

SIFS.... SOAR Integral Field Spectrograph

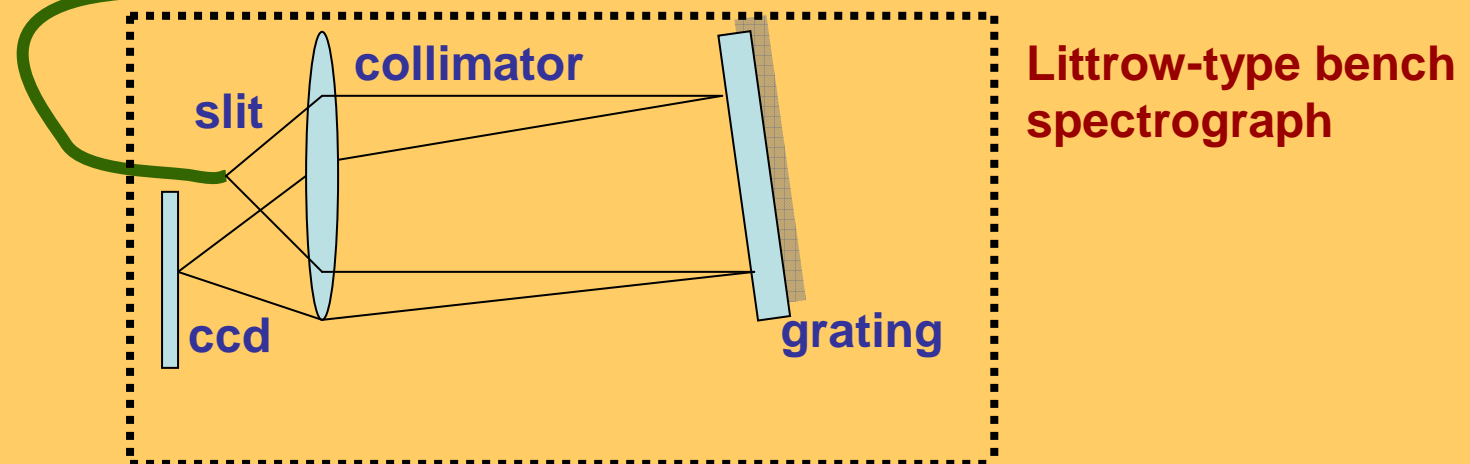
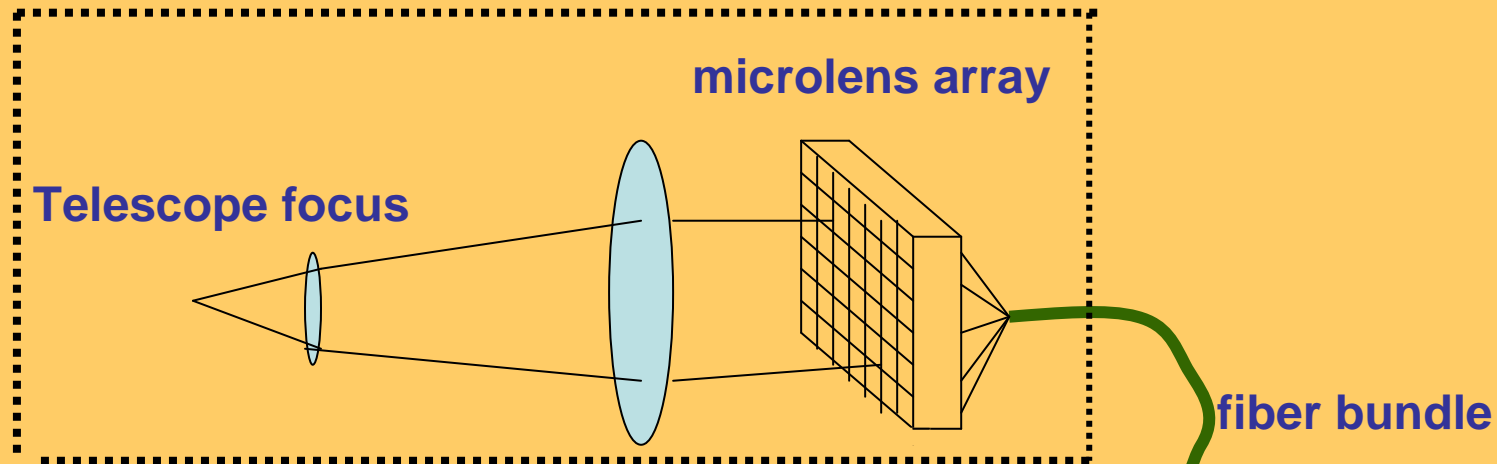
Jacques Lépine¹, Clemens Gneiding², Beatriz Barbuy¹,
Antônio César de Oliveira², Bruno Castilho², Antônio Kanaan³,
Militão Figueredo¹, Cesar Strauss¹, Rodrigo Prates²,
Celio Andrade², Francisco Rodrigues²
Pierre Bourget⁴ , Damien Jones⁵, David Lee⁶ + several others

- 1- IAG-USP Universidade de São Paulo, São Paulo, Brazil
- 2- LNA Lab. Nacional de Astrofísica, MCT, Itajubá, MG, Brazil
- 3- UFSC Universidade Federal de Santa Catarina, Brazil
- 4- ON Observatório Nacional, Rio de Janeiro
- 5- Prime Optics, 17 Crescent Road, EUMUNDI Q 4562 Australia
- 6- Anglo-Australian Observatory

SIFS prototype: Eucalyptus

a fiber Integral Field Spectrograph in operation at LNA

Fore-optics



SIFS main characteristics

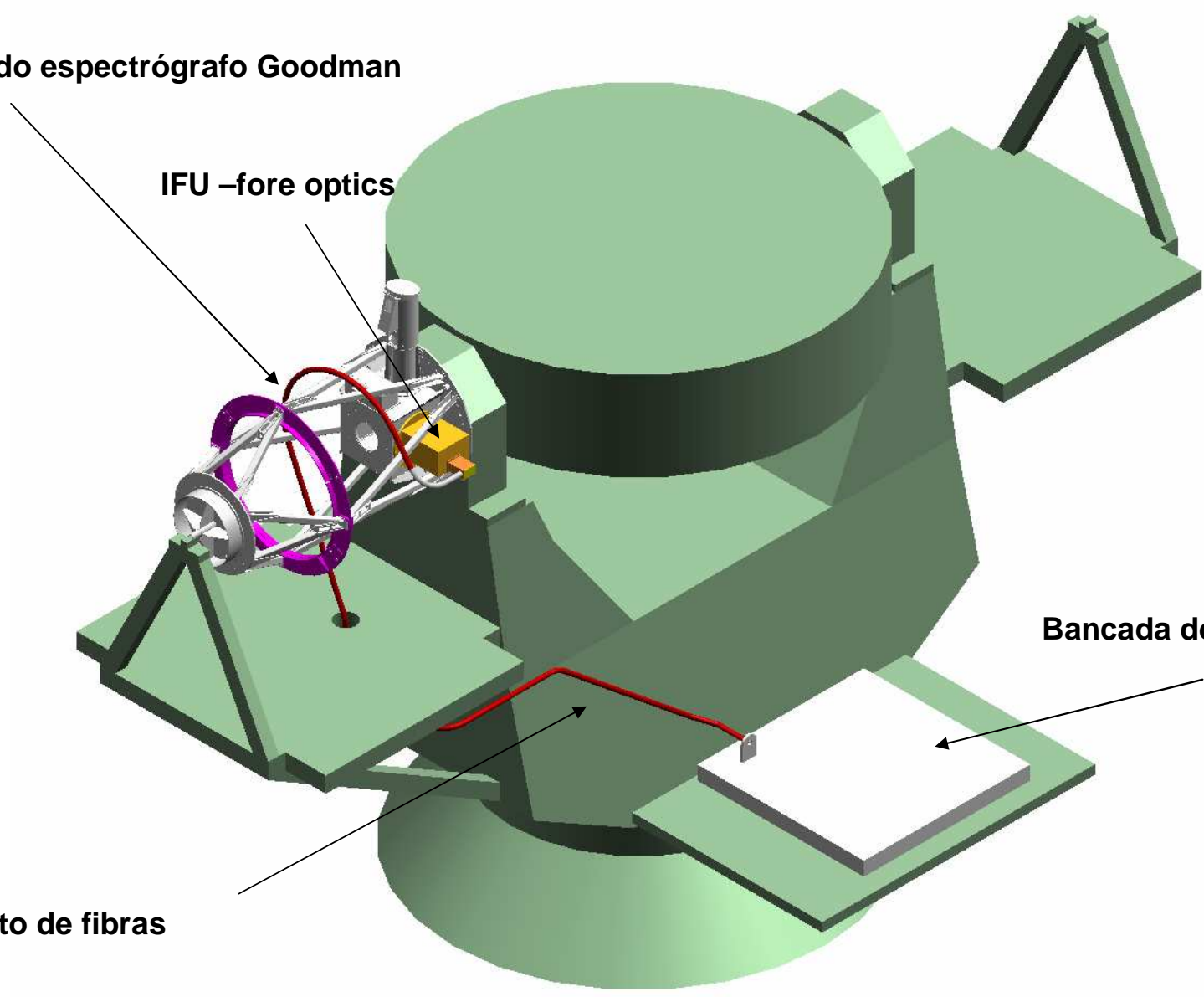
- **1300 fibers** 26x50 microlens array + a 5x5 sky subtraction array
1mm x 1mm lenses
50 μm core Polymicro fibers
- **Interchangeable fore optics magnification: 2 field sizes**
0.30 arcsec/mm field 15 x 7.8 arcsec
0.15 arcsec/mm field 7.5 x 3.9 arcsec
room for a third one TBD
- **Interchangeable VPH gratings : a set of 5 resolution x λ choice**
spectral resolution 2000 -20000
- **all lenses coated with SolGel**
- **4k x 4k CCD mosaic, same CCD camera of other SOAR instruments**

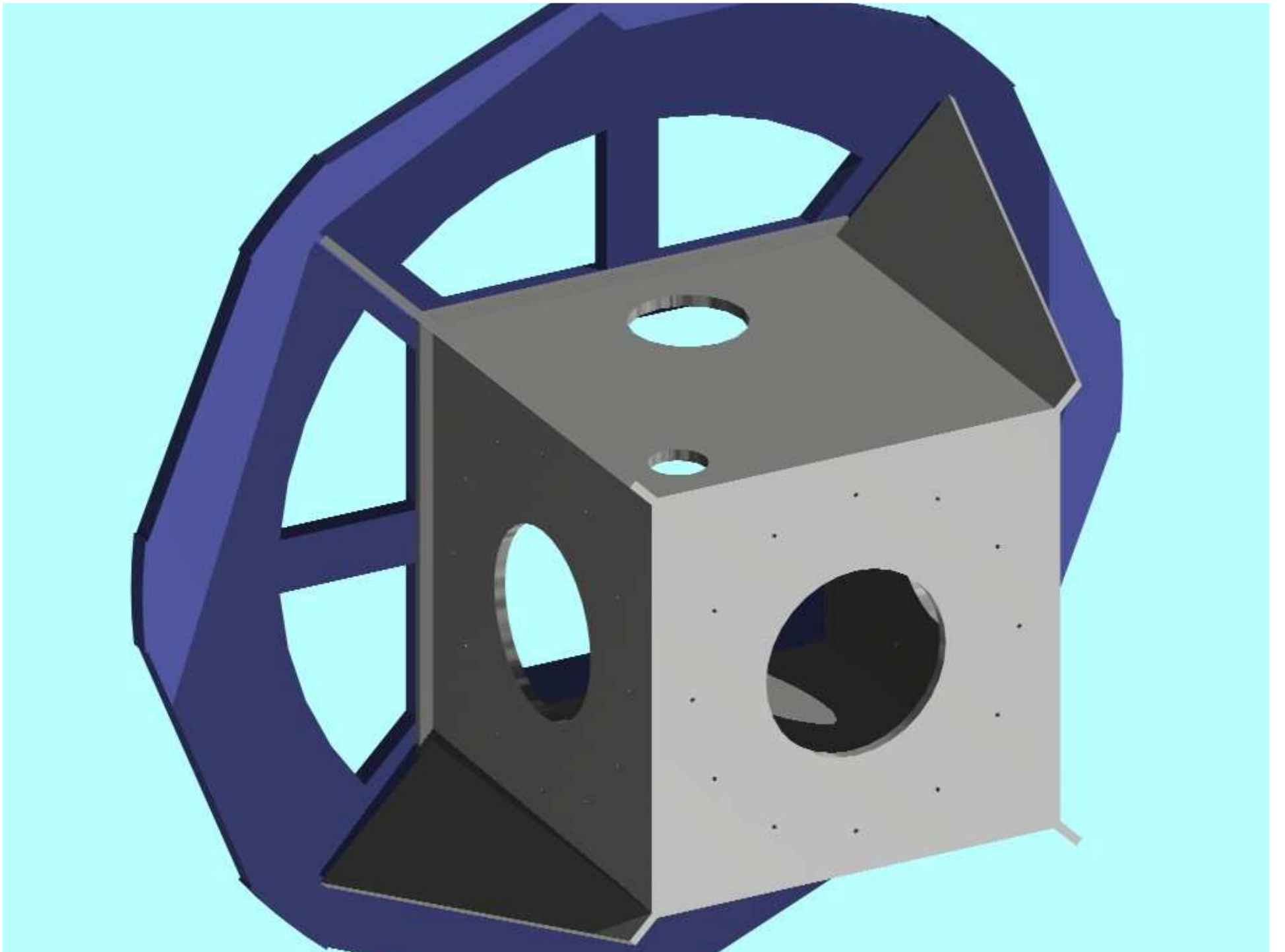
Gaiola do espectrógrafo Goodman

IFU –fore optics

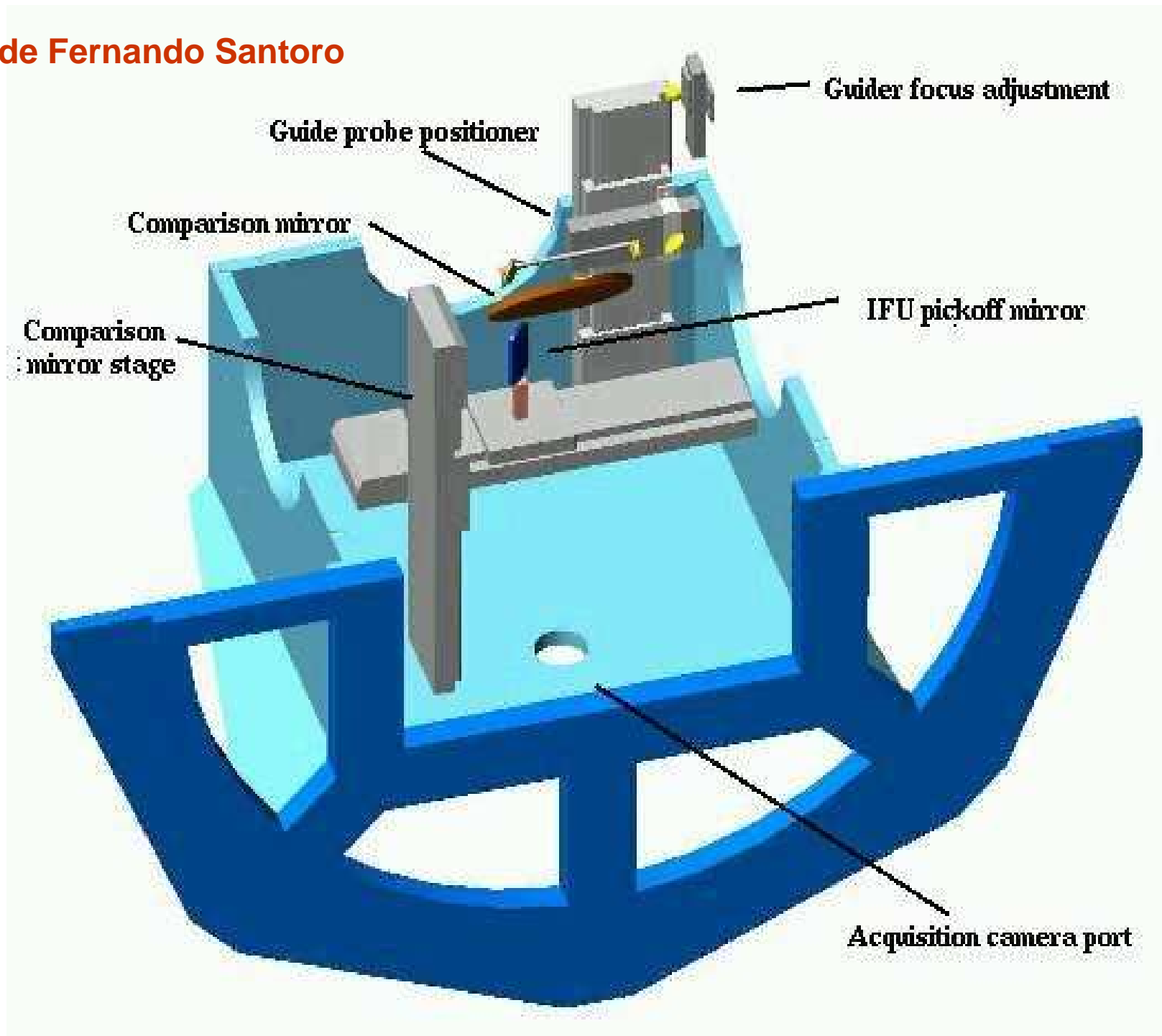
Bancada do espectrógrafo

Duto de fibras





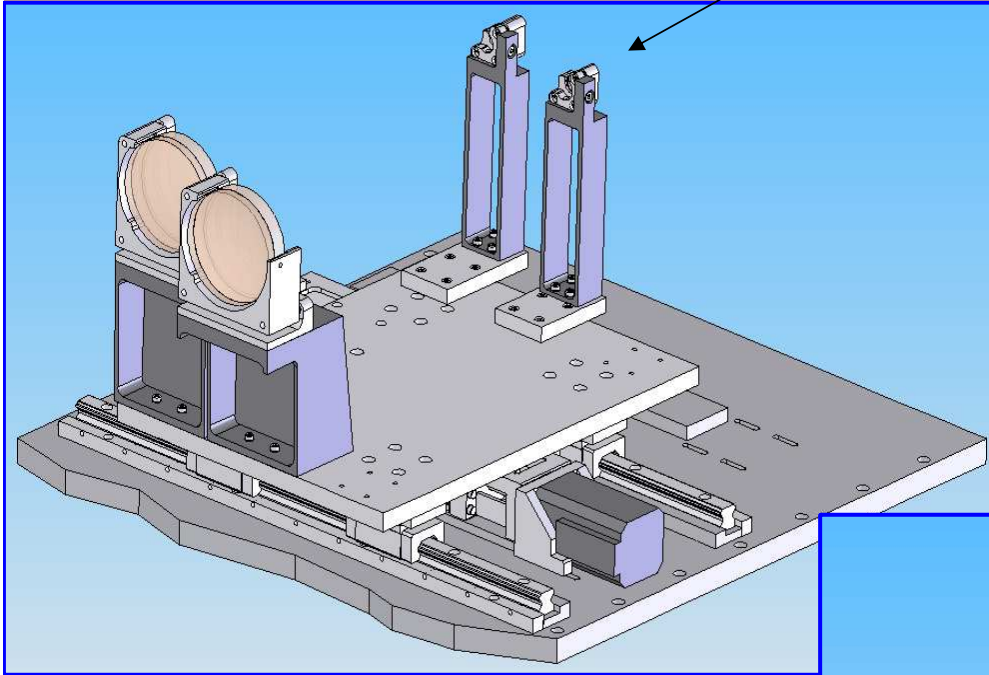
Projeto de Fernando Santoro



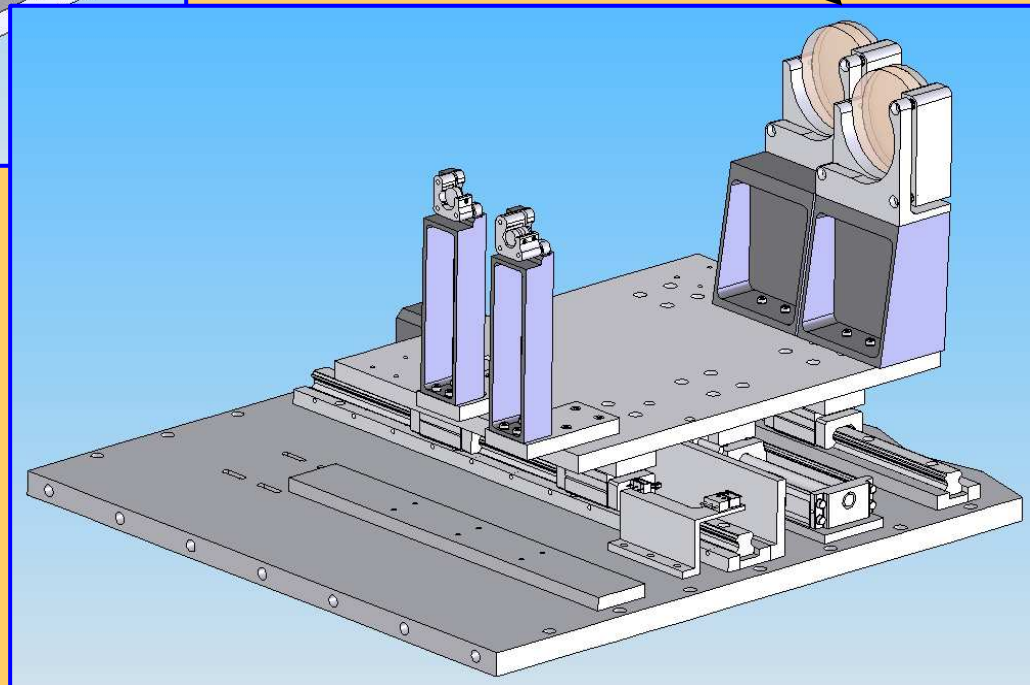
Uma parte pronta: a caixa do fore-optics

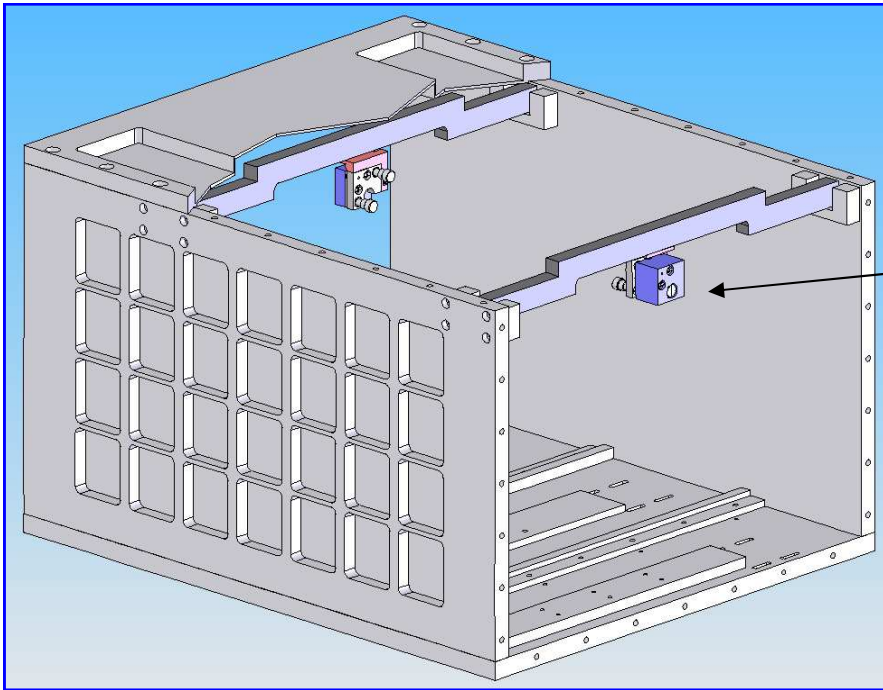


lentes de magnificação

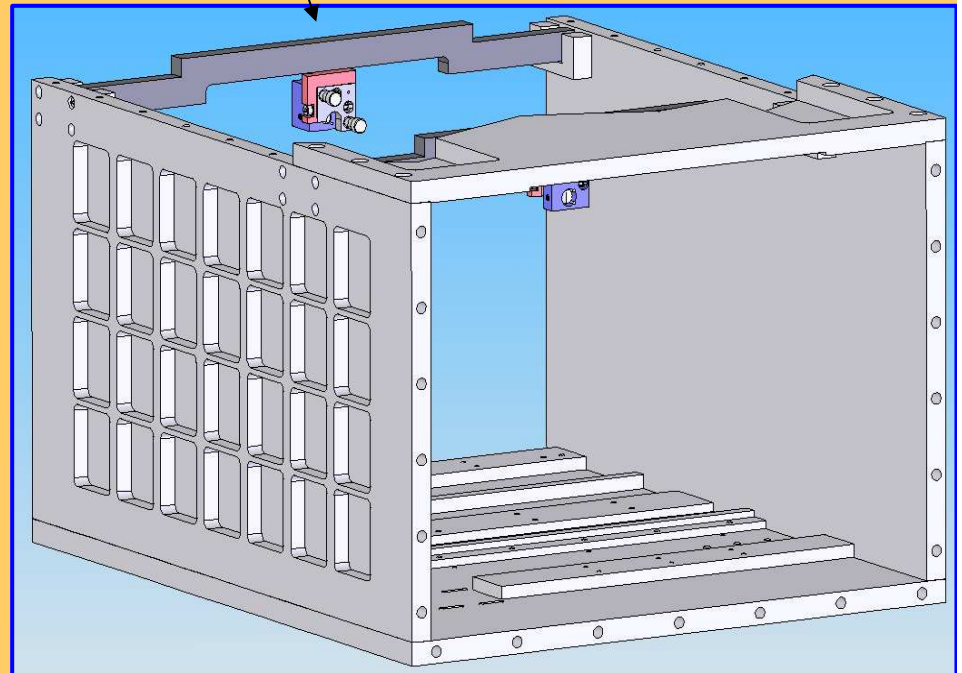


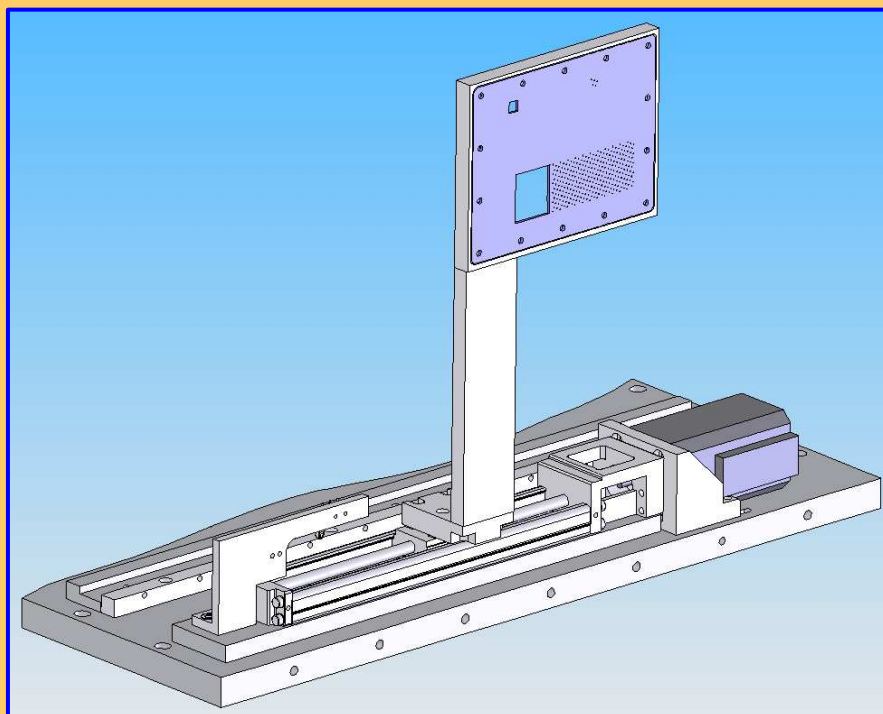
lentes de campo





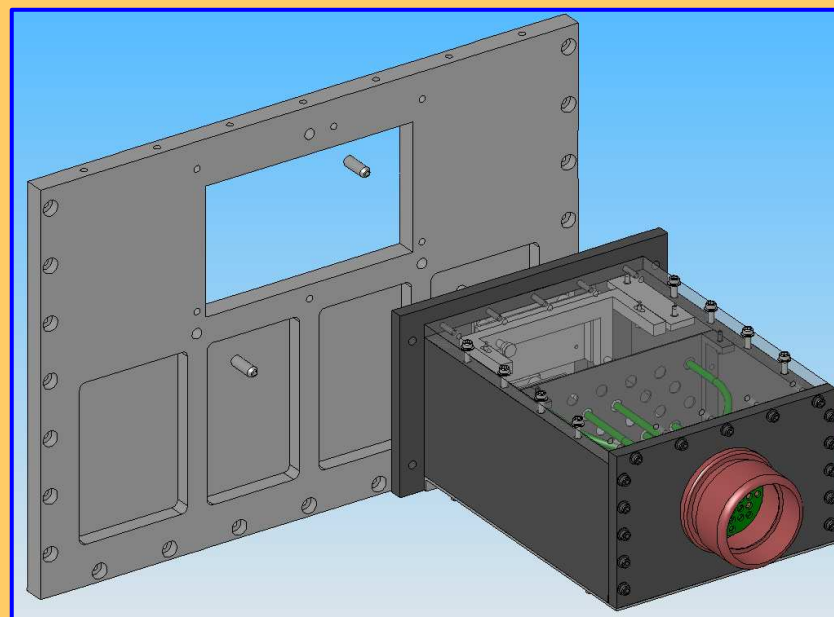
Suporte das lentes do IFU de céu



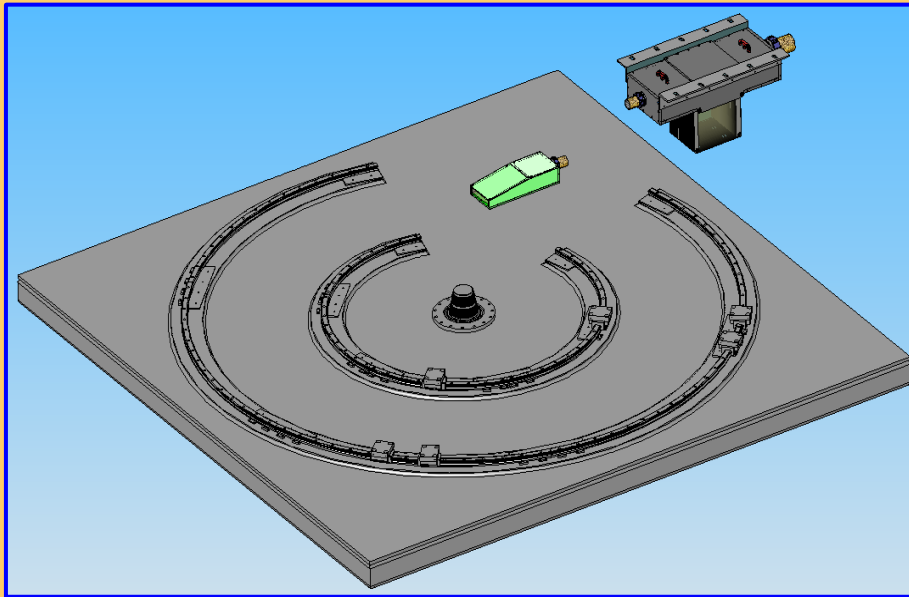


suporte de mascara (bolada por Bruno Castilho) com furos para calibração

**caixa de entrada das fibras,
com suporte para matriz de microlentes**



caixa de alívio do stress das fibras

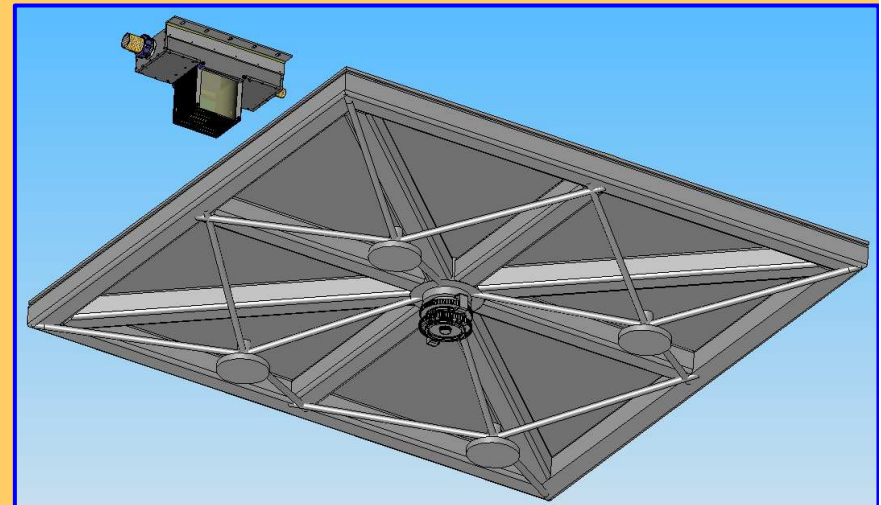


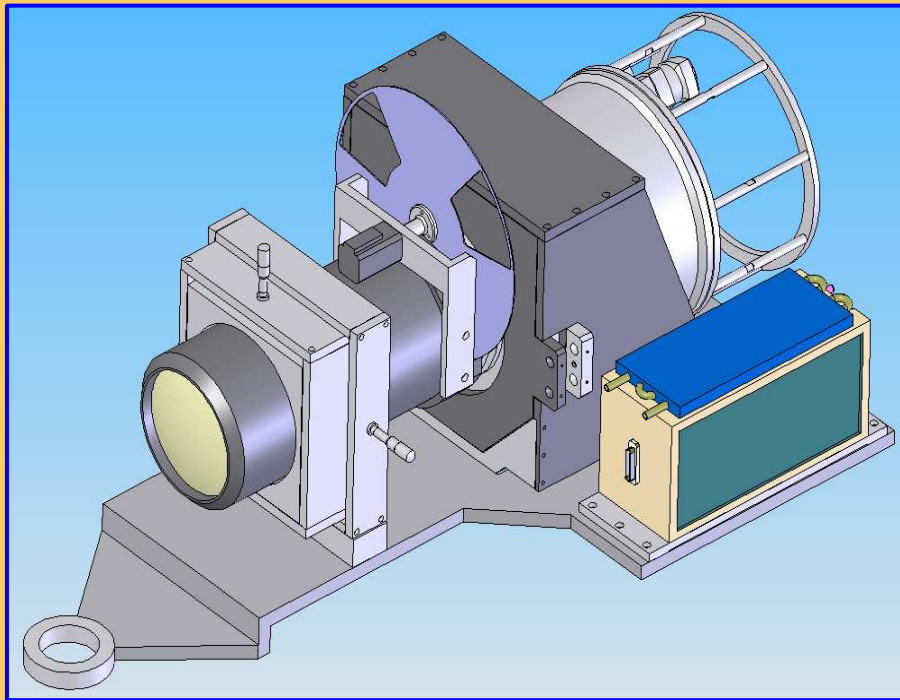
bancada do espectrografo

material : estrutura de colméia
(honeycomb)

2,4 x 2,4 m

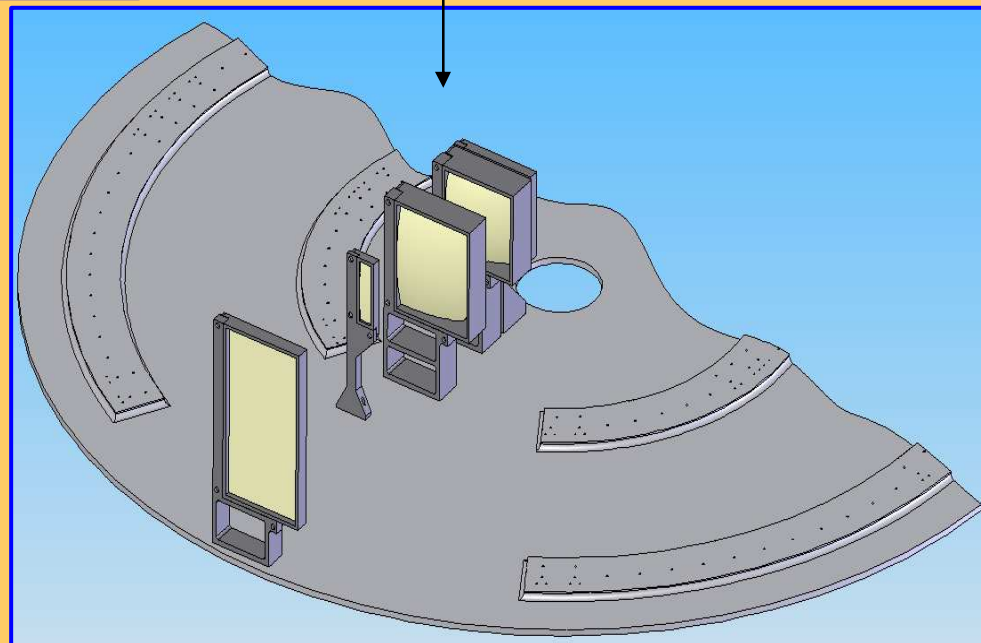
Trilhos THK para deslocamento da
camera + detetor CCD,
e da rede de difracção.

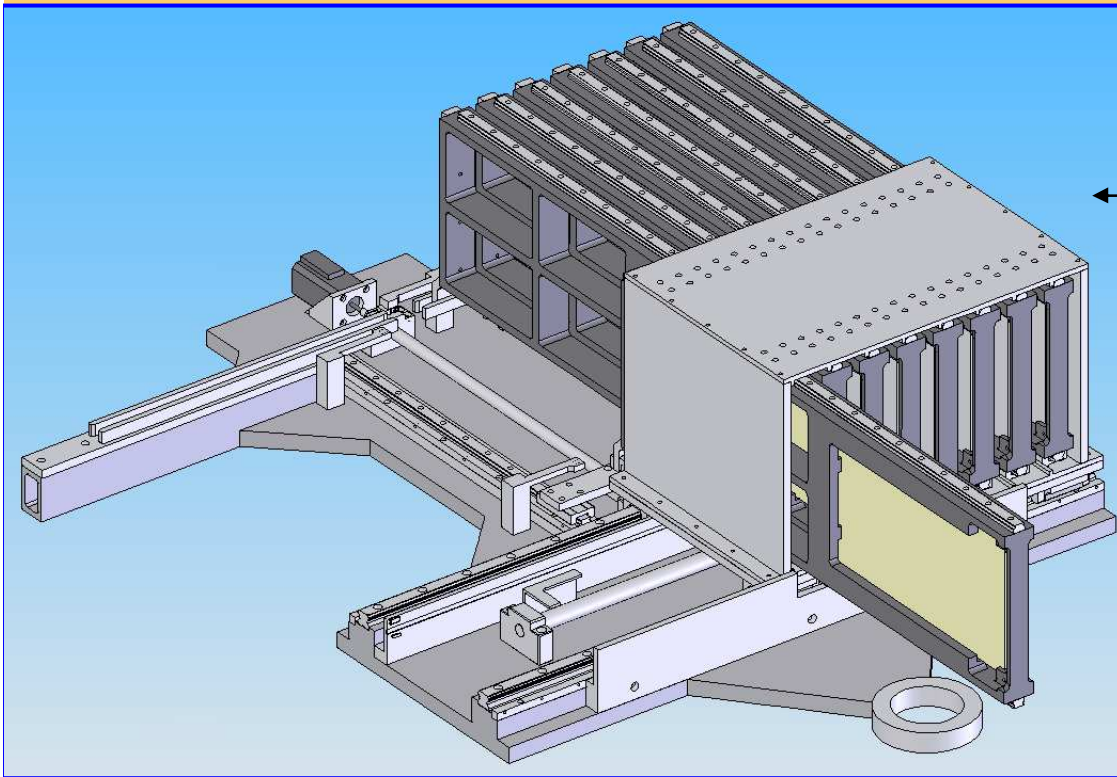




Camera + dewar + Leach Controller

lentes do colimador

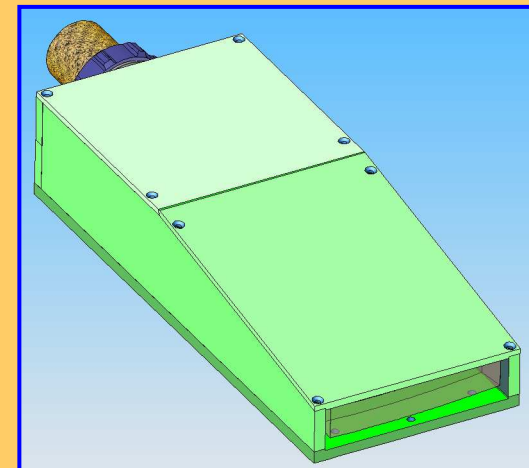
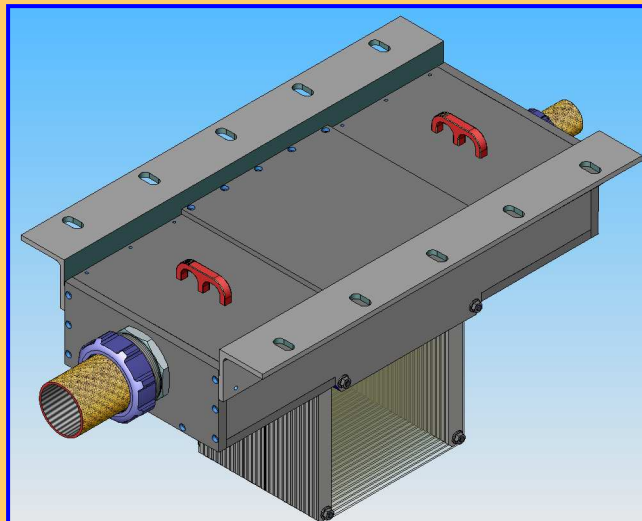




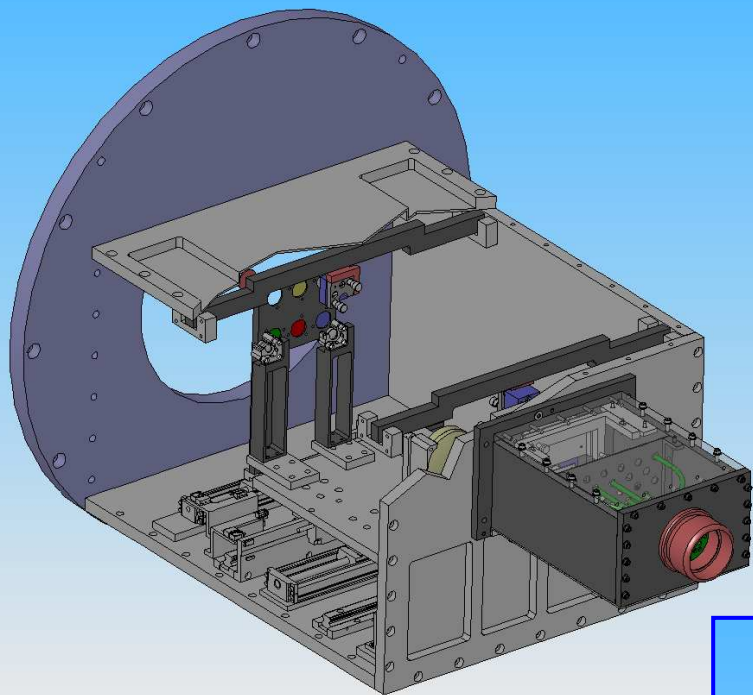
trocador de redes de difração

**terminal do feixe de fibras
com "fenda"**

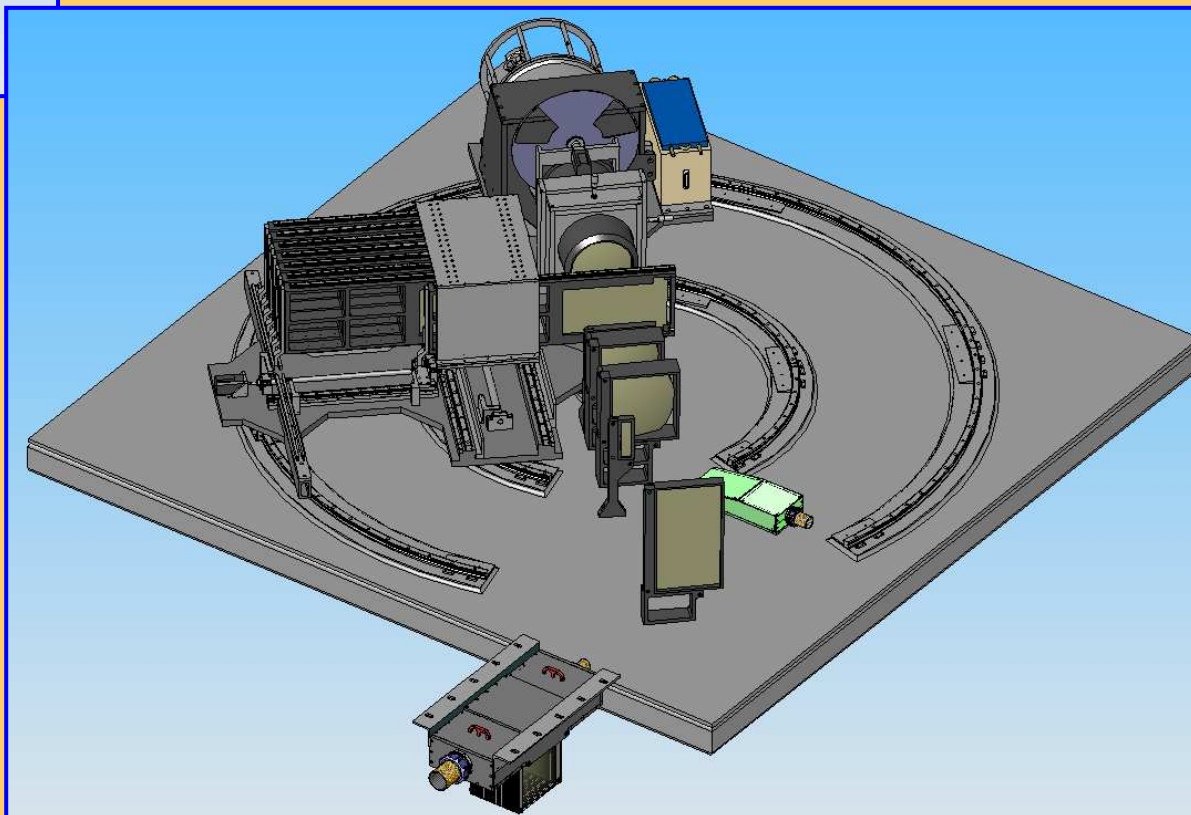
**caixa de alívio
de tensões**



vista geral do Fore-optics

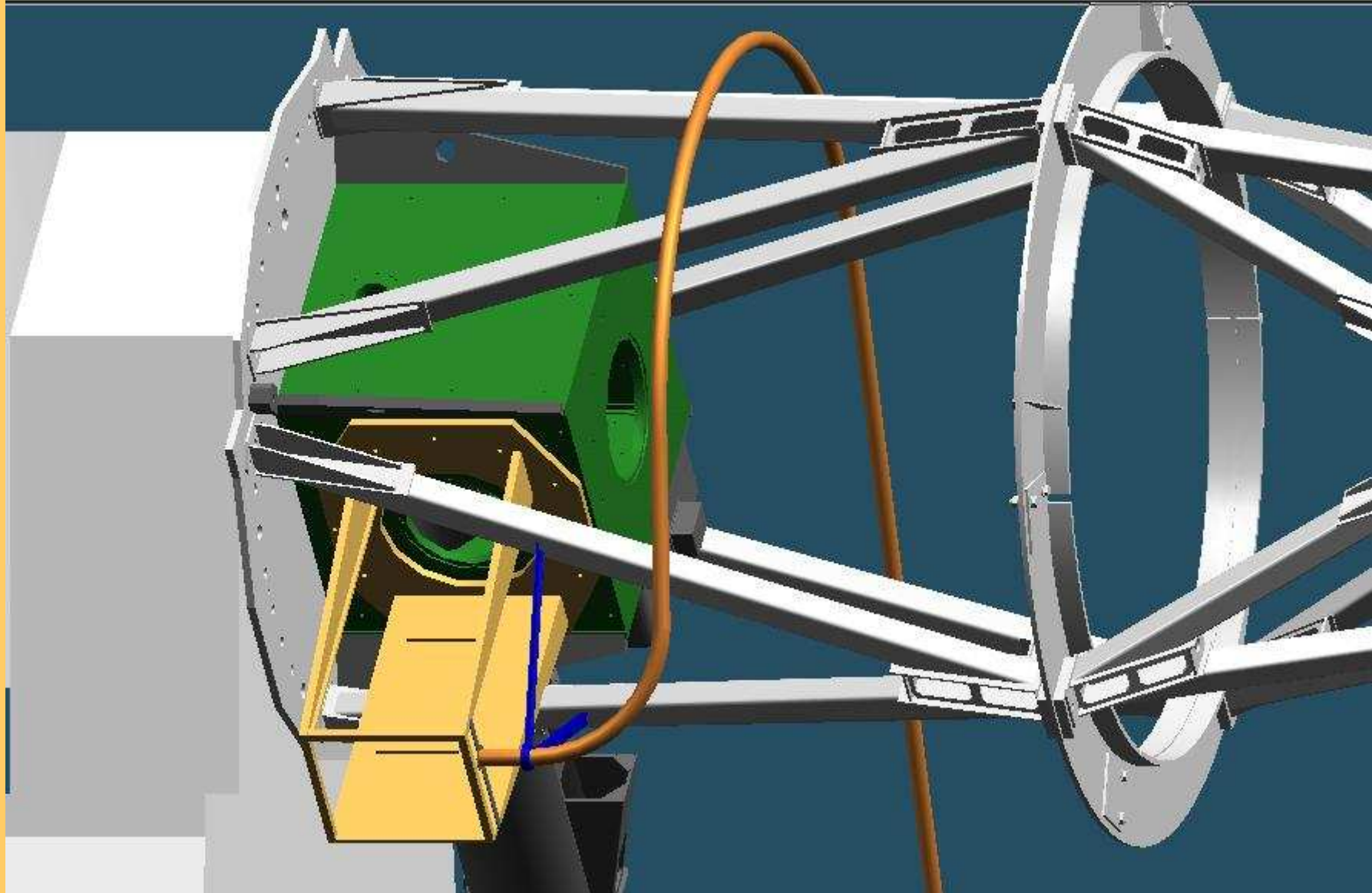


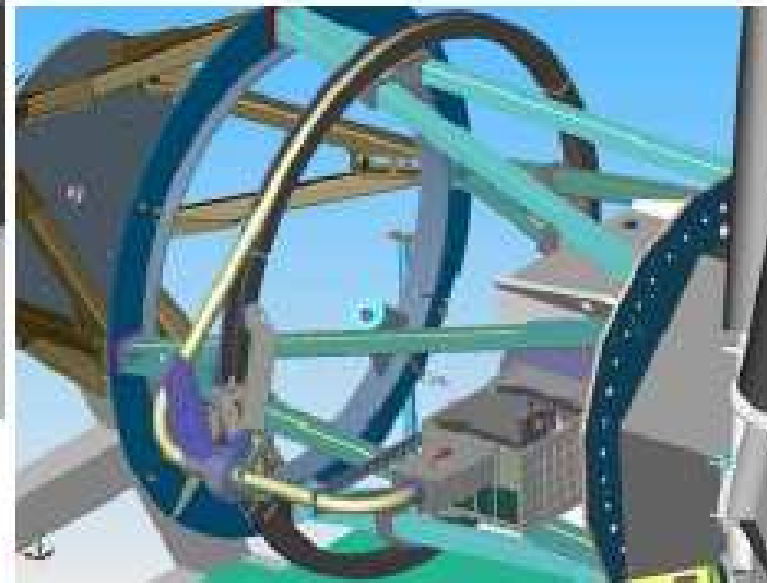
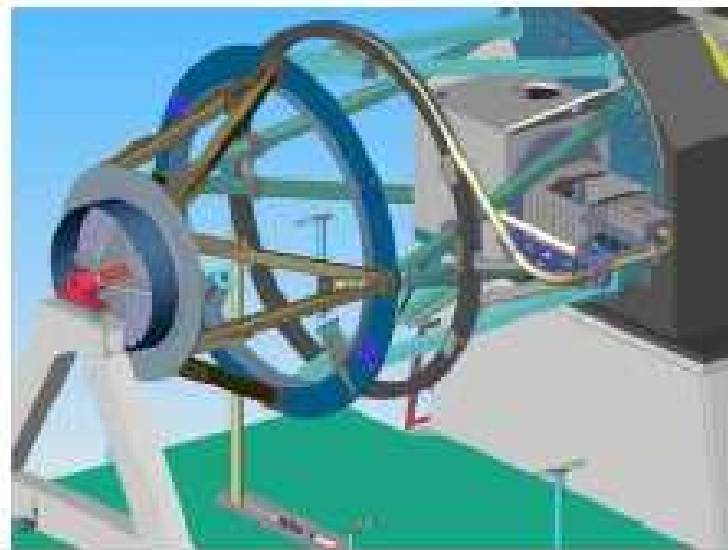
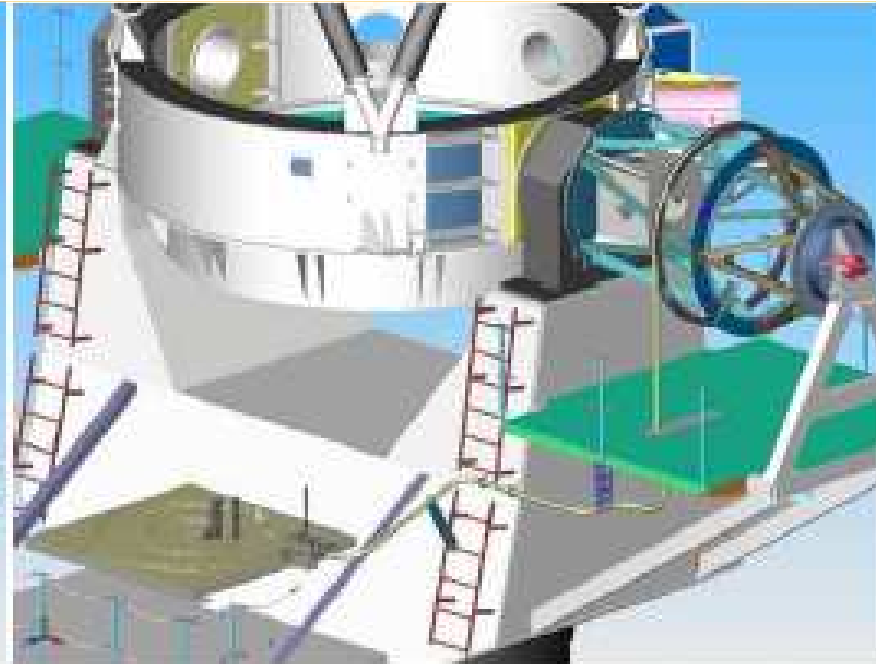
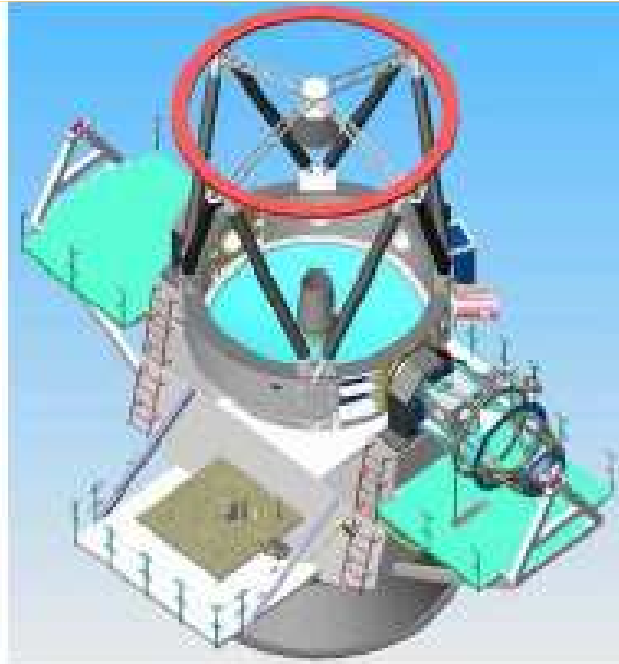
**vista geral do espectrógrafo
de bancada**



Várias etapas no cálculo do comprimento do feixe de fibras

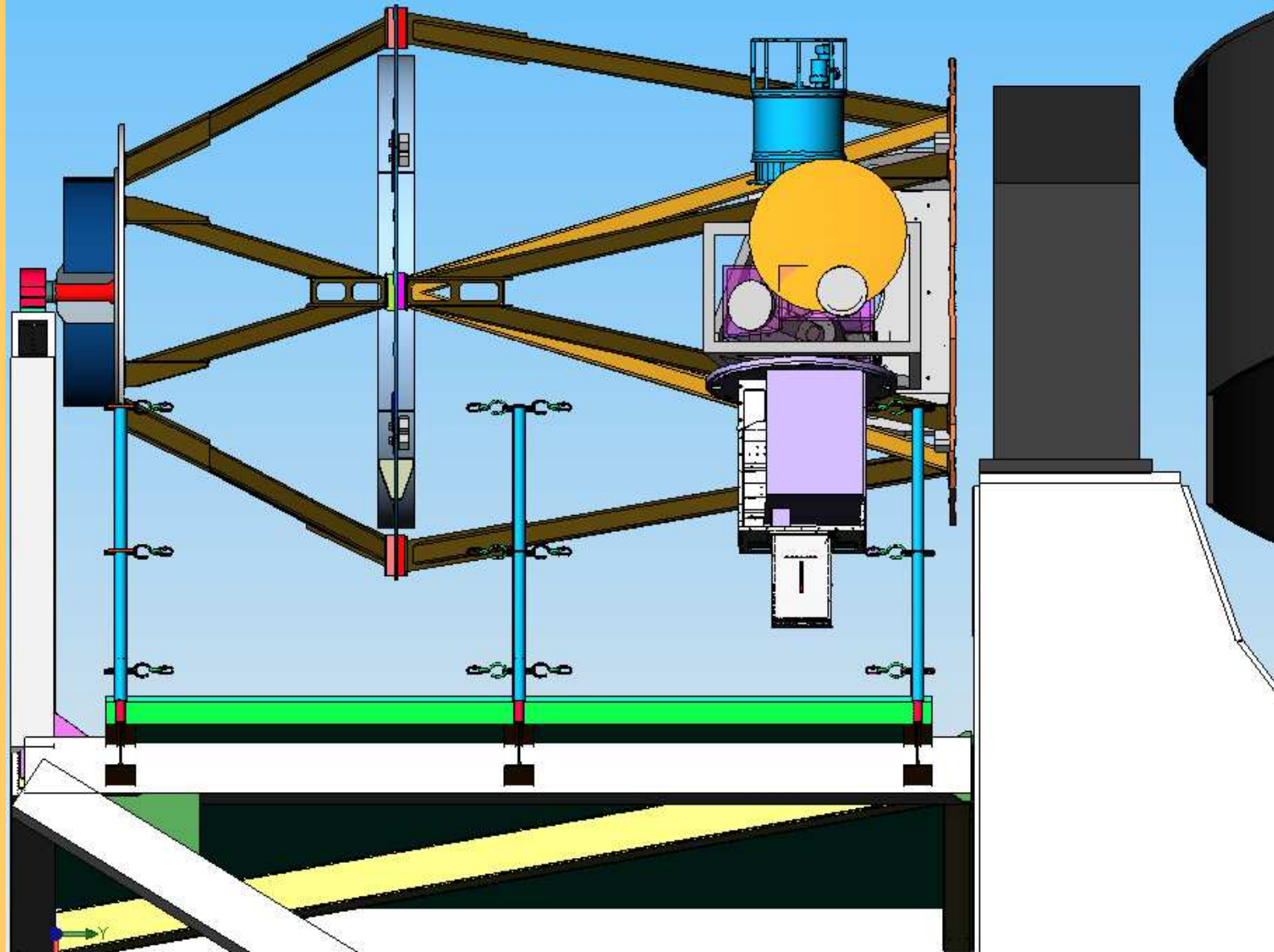
1) Militão





2) Fernando Santoro

3) Nova posição do módulo AO



Situação atual

- grande atraso acumulado em quase totalidade devido a importações
outras causas de atrasos:
 - indefinição nos motores a serem usados (comuns a todos os instrumentos)
Silvermax
 - indefinição no comprimento total do cabo (por conta do modulo AO)
- encontra-se no país o primeiro lote de lentes
- redes de difração foram despachadas pelo fabricante
- contrato assinado com a LEG Engenharia prevê entrega da parte mecânica do fore-optics em março e parte mecânica do espectrógrafo em outubro
- pagamento do segundo e último lote de lentes autorizado pela FAPESP (início da importação)

Dificuldade técnica : construção do bloco com 1300 furos com posições com 5 microns de precisão

situação favorável: -desenvolvimento de software de aquisição e redução não sofre atraso devido ao resto
- fabricação da unidade IFU-fibras corre de forma quase independente do resto

Dificuldade técnica : construção do bloco com 1300 furos com posições com 5 microns de precisão (antes, a cargo de Pierre Bourget, ON)



Situação favorável: -desenvolvimento de software de aquisição e redução não sofre atraso devido ao resto (Antonio Kanaan, Bruno Castilho....

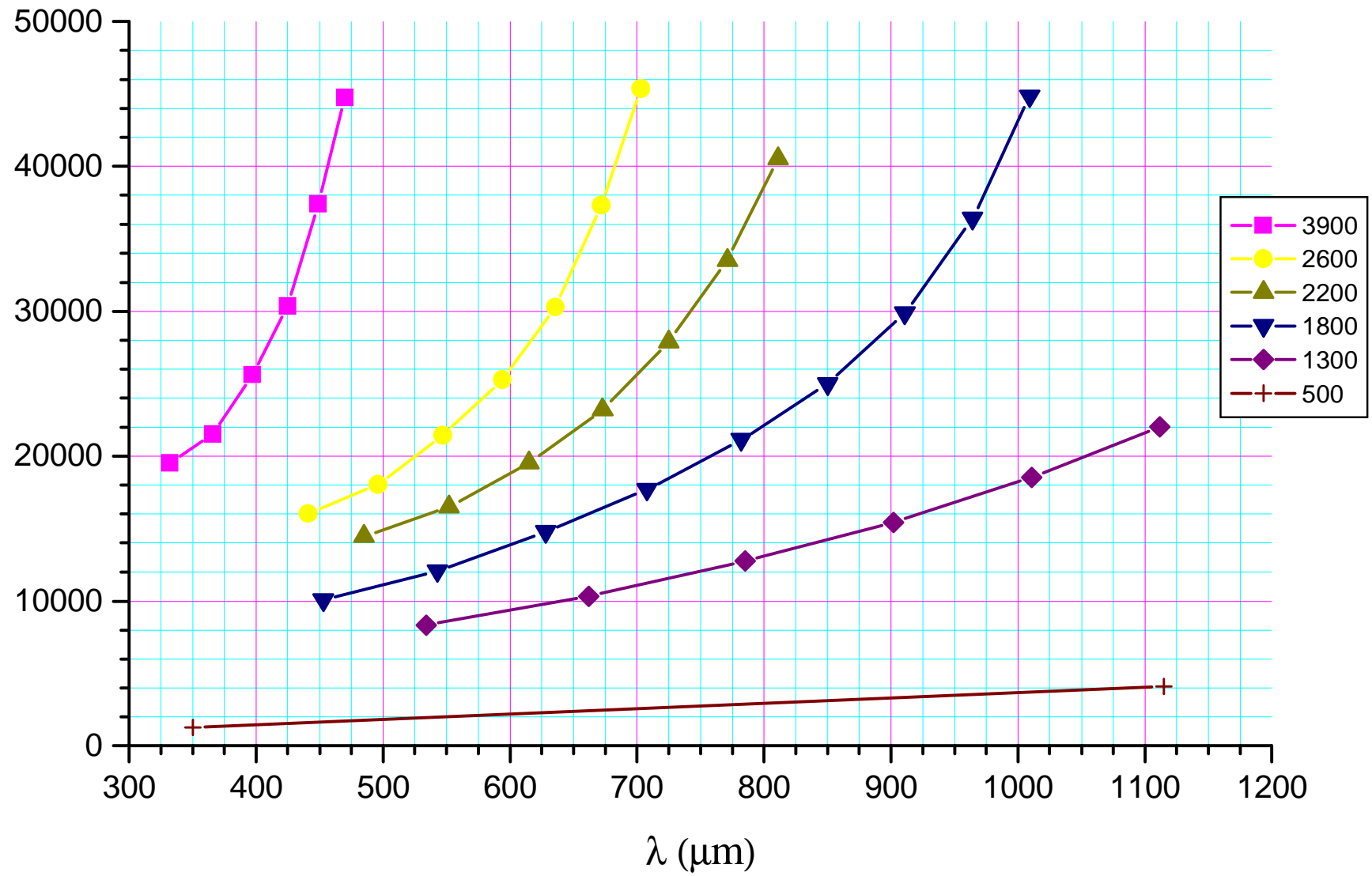
- fabricação da unidade IFU-fibras corre de forma quase independente do resto (Antonio Cesar de Oliveira)

Fiber support block (previously being constructed by Pierre Bourget -ON)





RESOLUTION

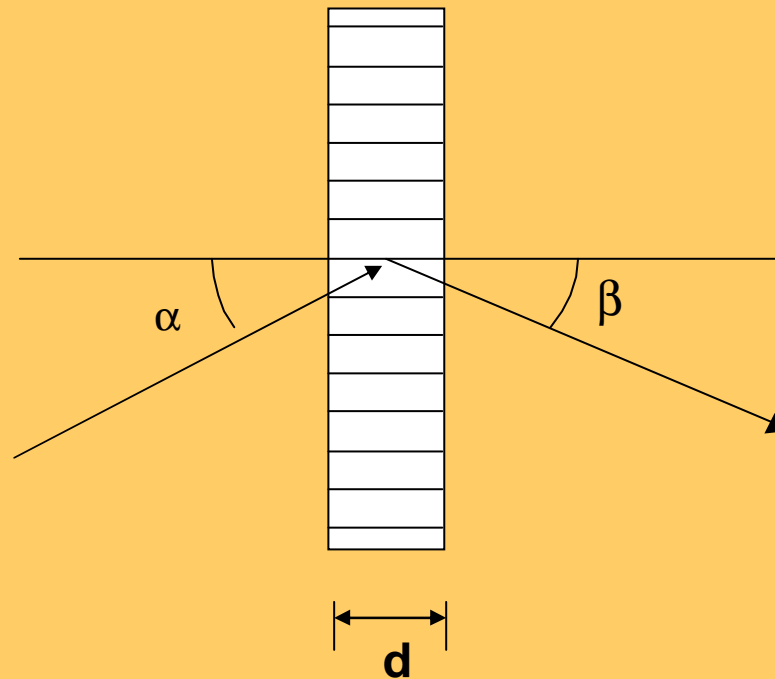


Example of a set of 6 VPH gratings

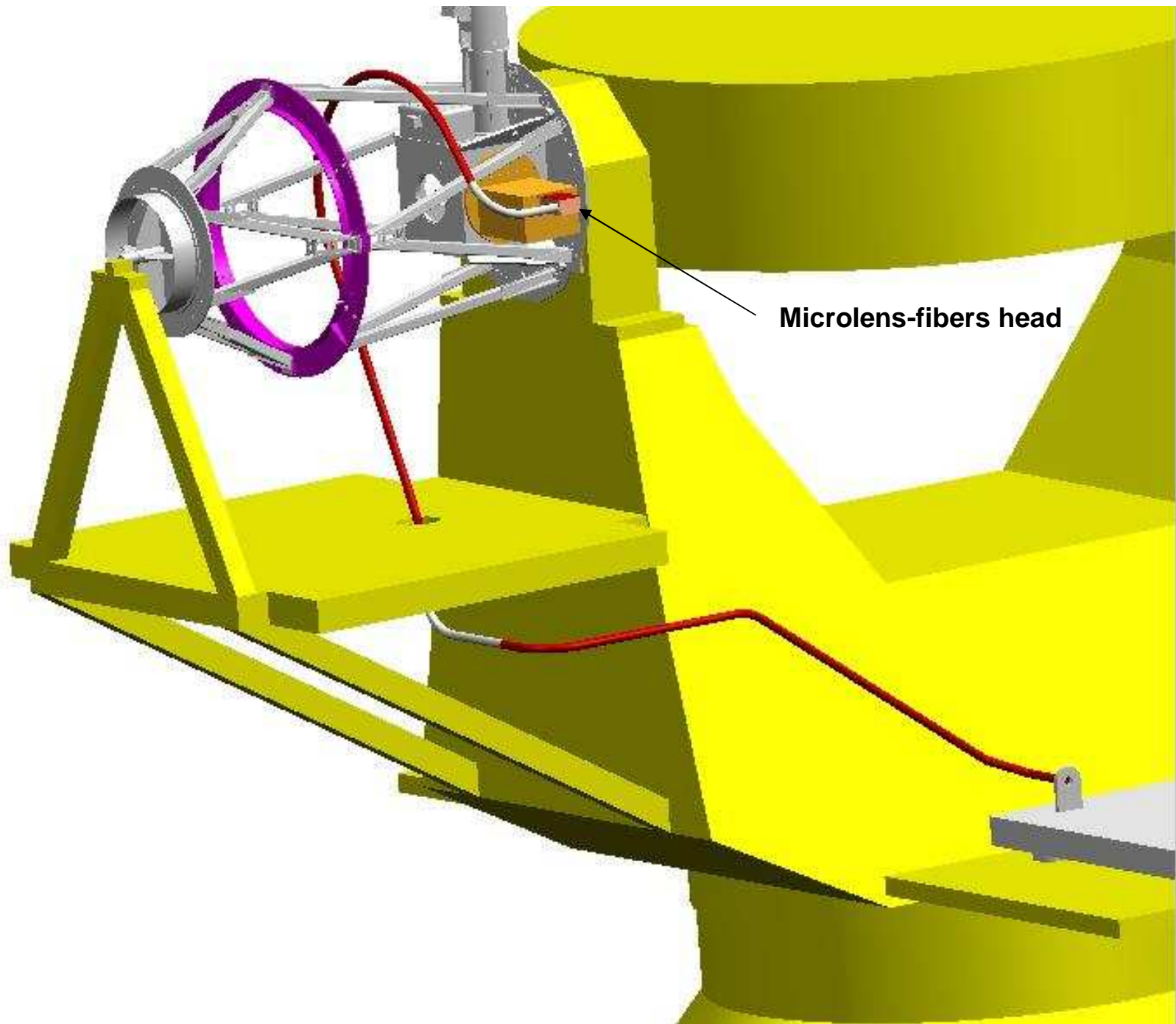
(Militão Figueiredo)

Frequency (gr/mm)	Δn (for $n=1,5$)	d (μm)
500	0,040	9,1
1300	0,075	4,0
1800	0,075	4,0
2200	0,07	5,0
2600	0,05	5,5
3600	0,04375	4

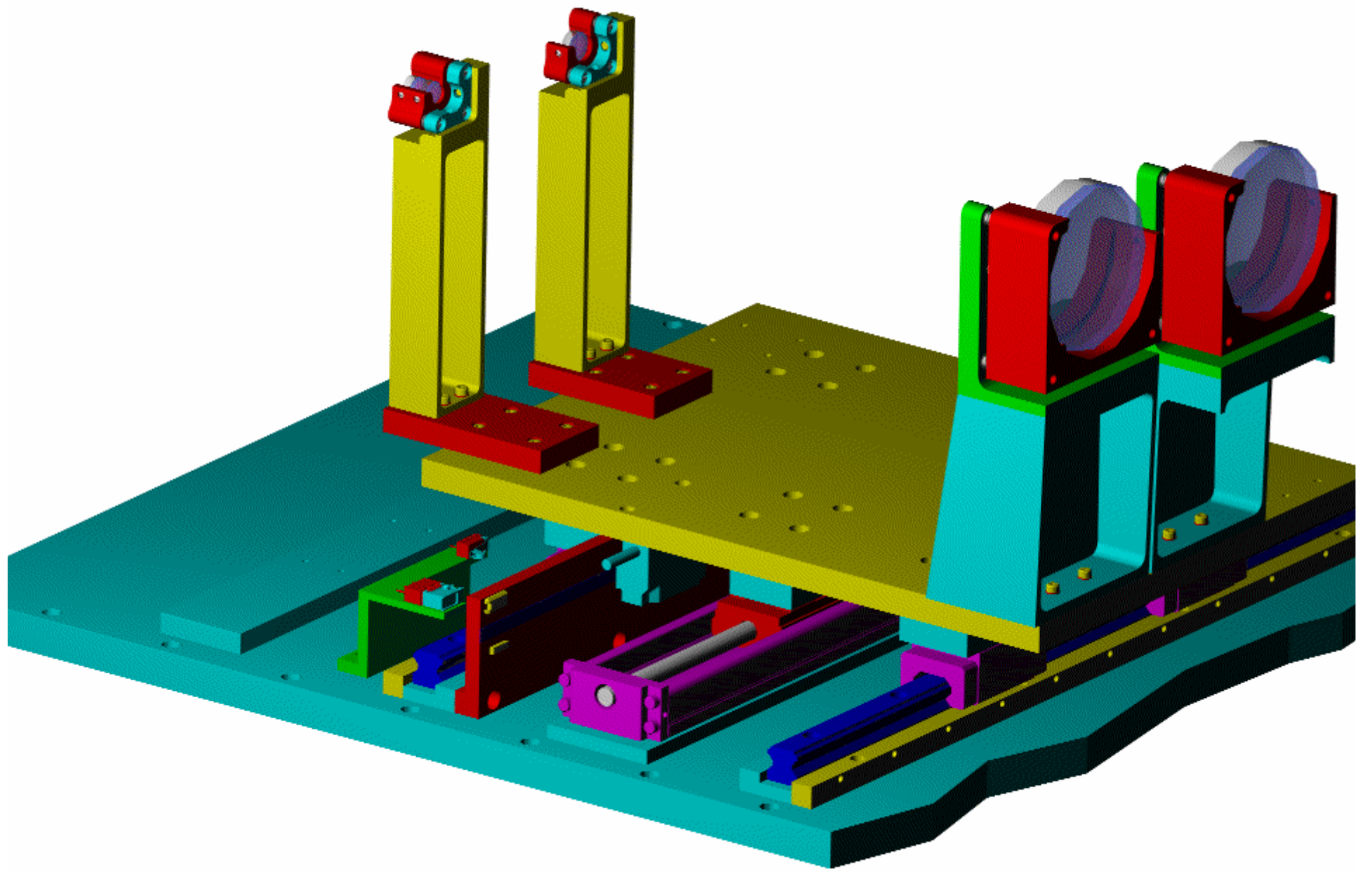
(Between two 3-mm BK7 substrates)



Thickness of the gel

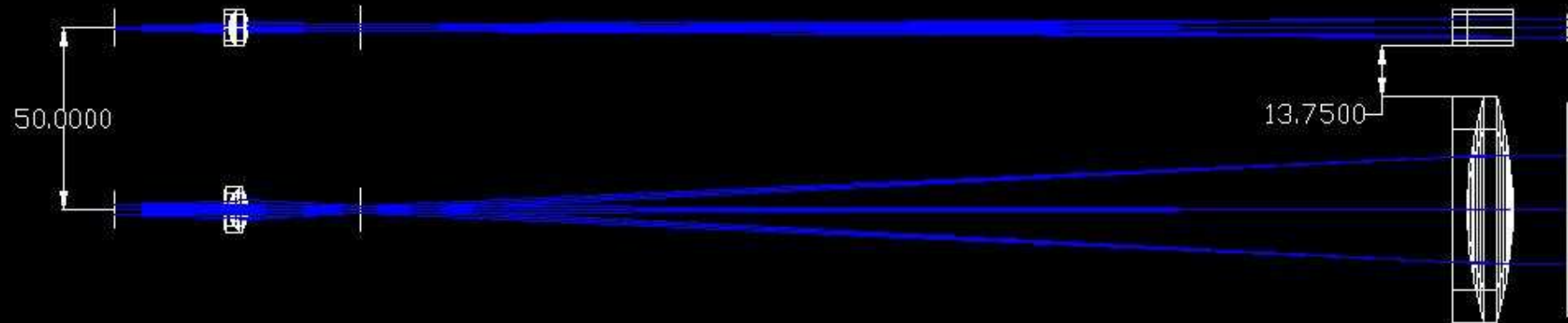


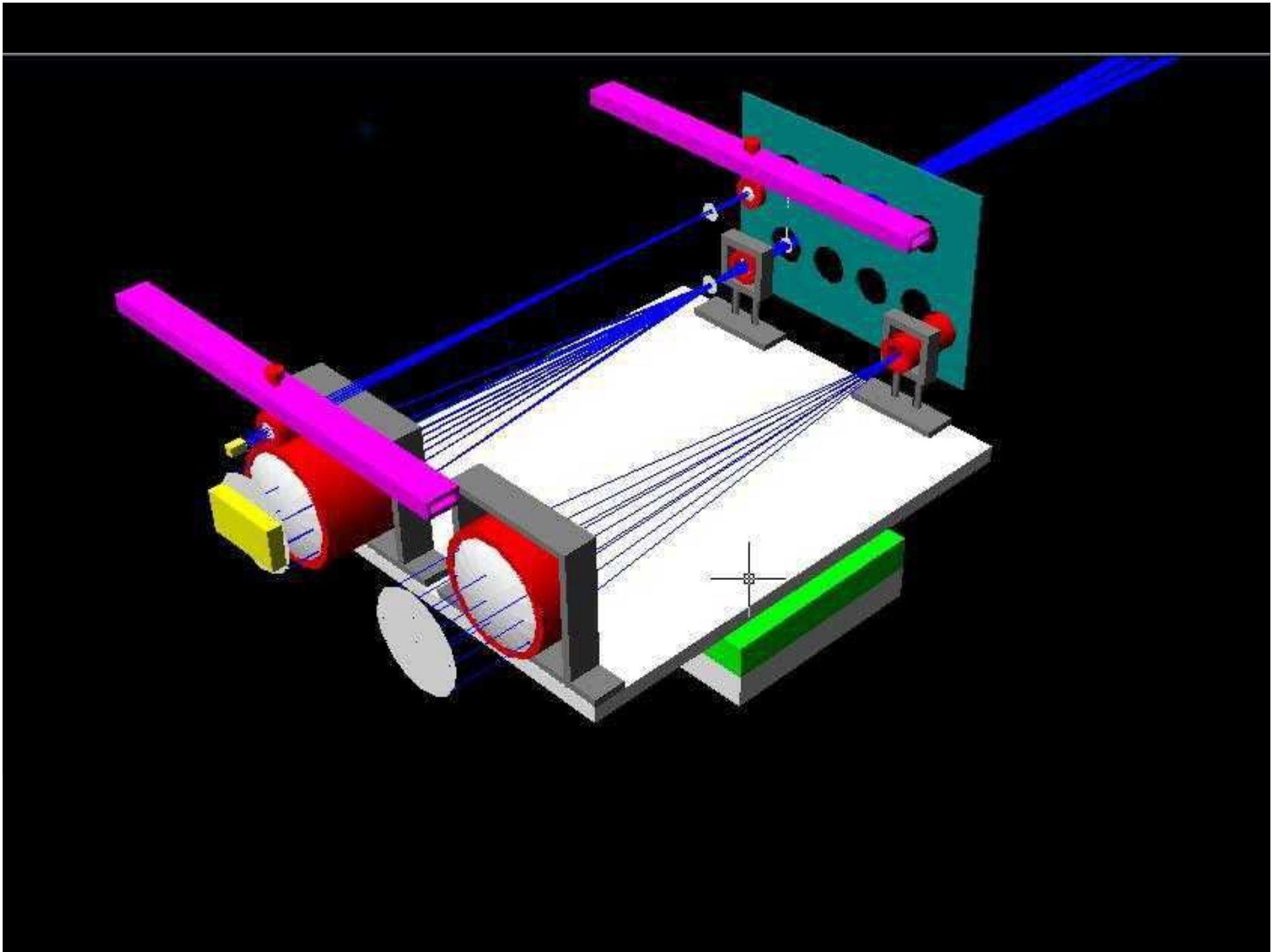
Microlens-fibers head



IFU fore-opticsmagnification x 10 + sky subtraction IFU

2.5 arc min at telescope focus = 50 mm
limitations: size of pick-off mirror
diameter of field lens





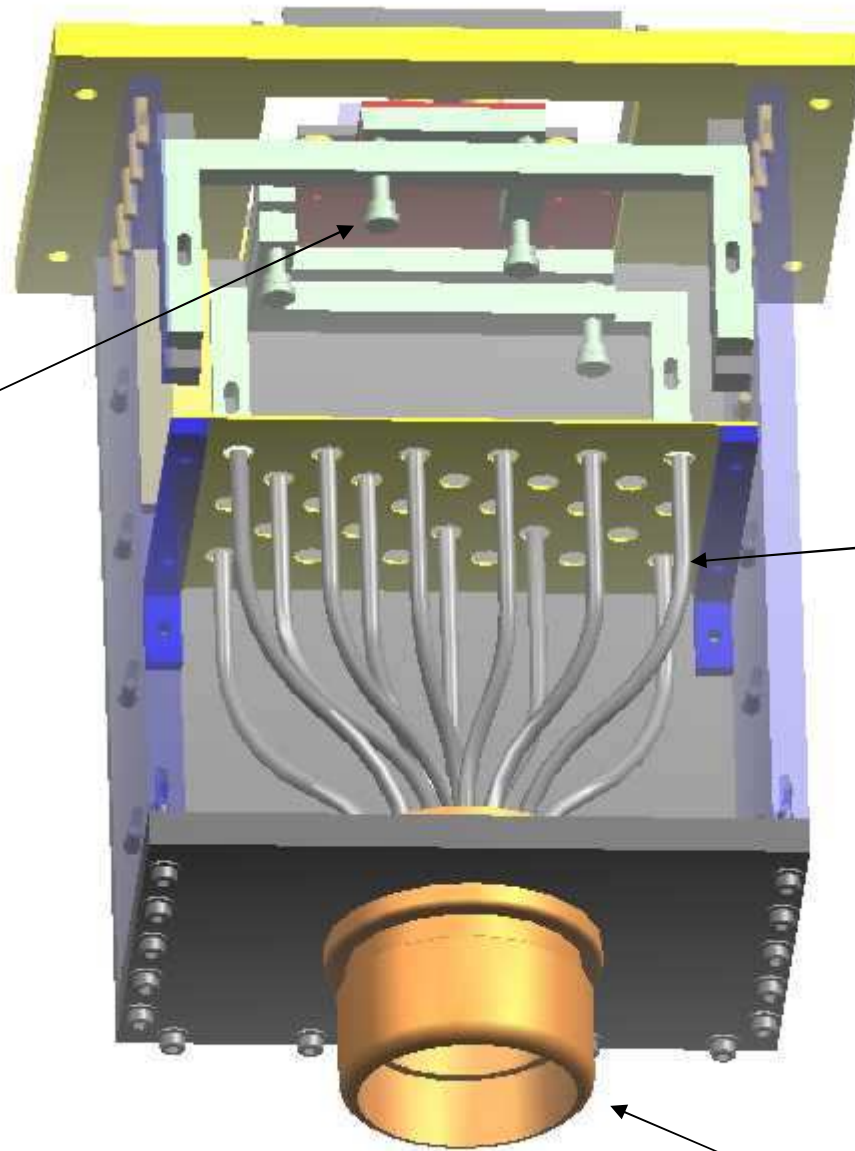
Microlens-fibers head

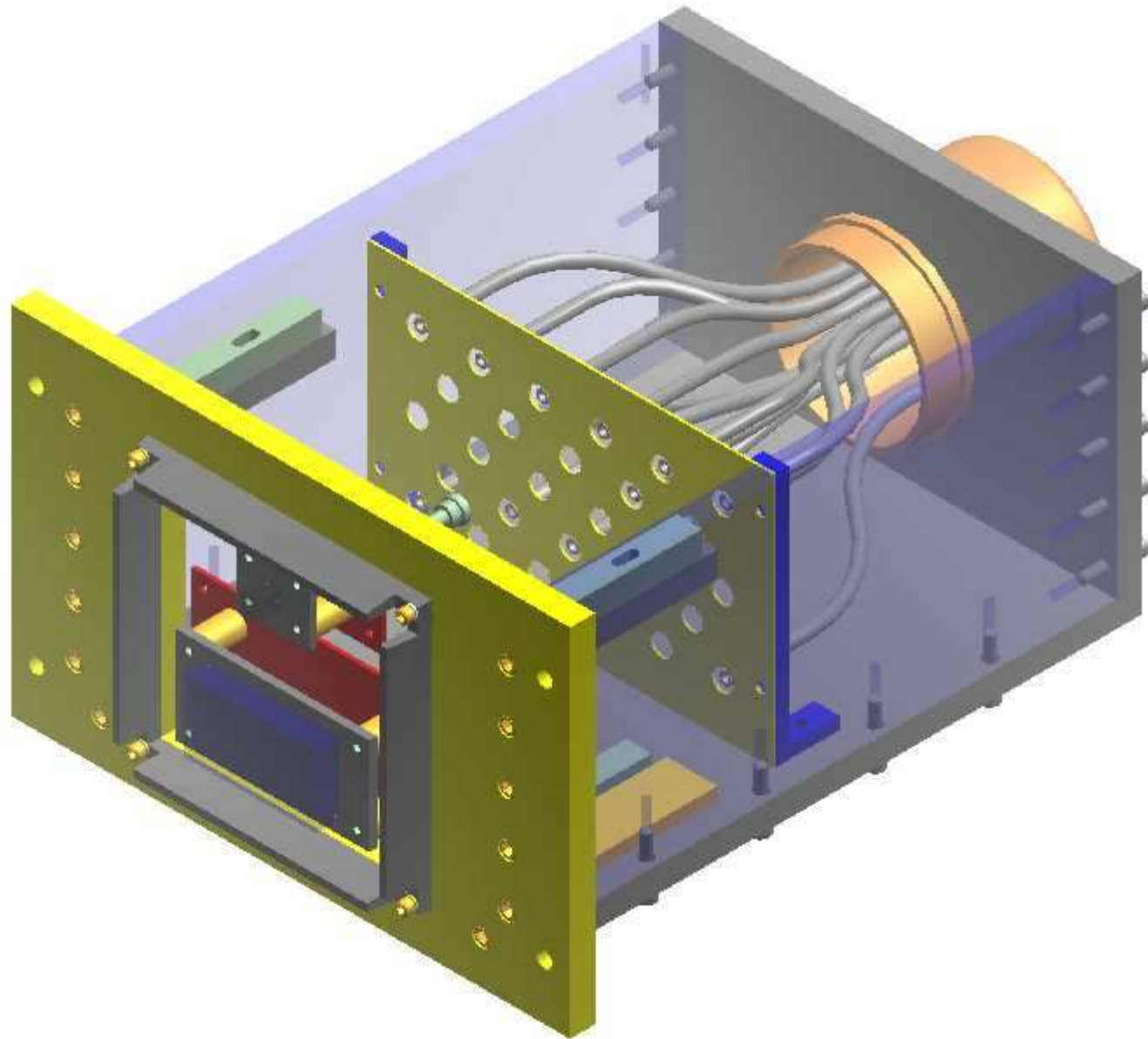
Fore optics box side

**Microlens arrays
fine
positioning**

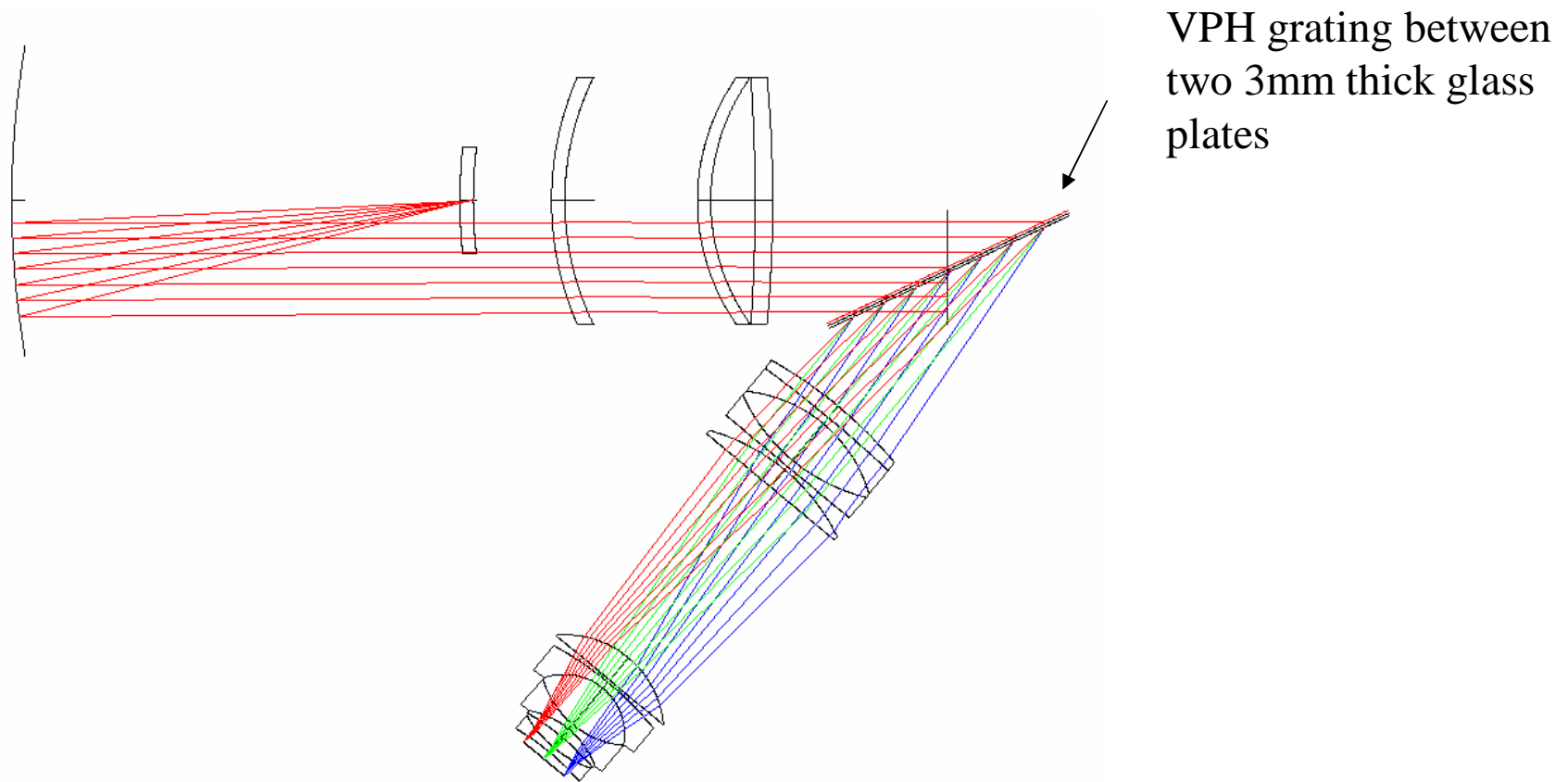
Furcation tubes

Fiber bundle support

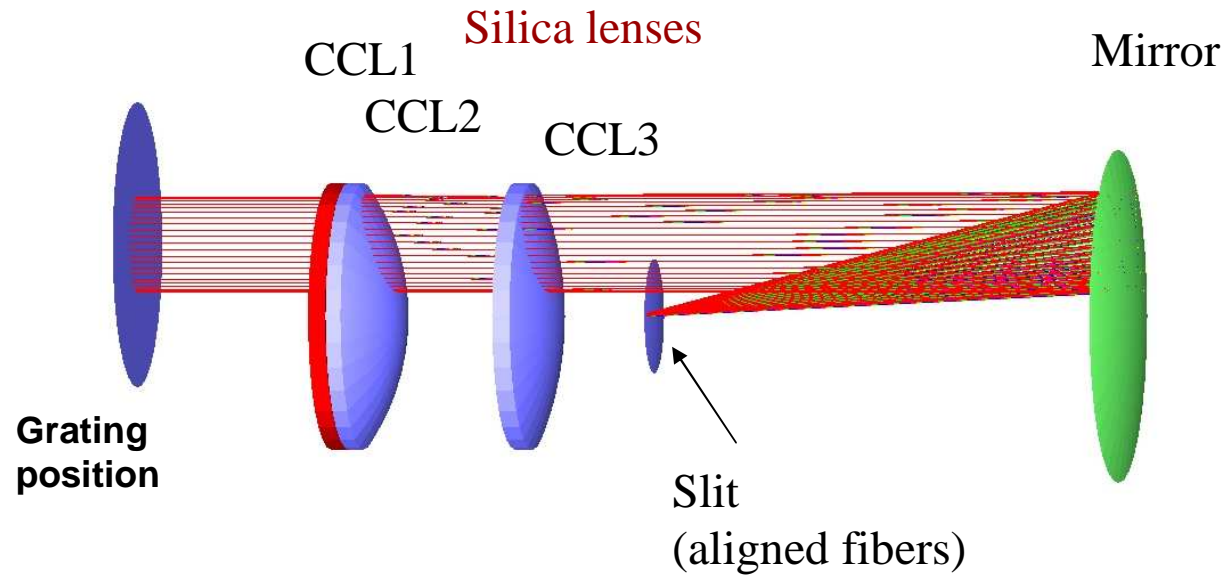




Collimator + grating + camera



Catadioptric collimator (designed by Damien Jones)



The pupil and exit pupil are *offset* in the y-direction. The near collimated beam from the mirror is designed to clear the slit by nearly 25 mm. Off-axis portions of CCL1, 2, 3 & CCLM are to be utilized.

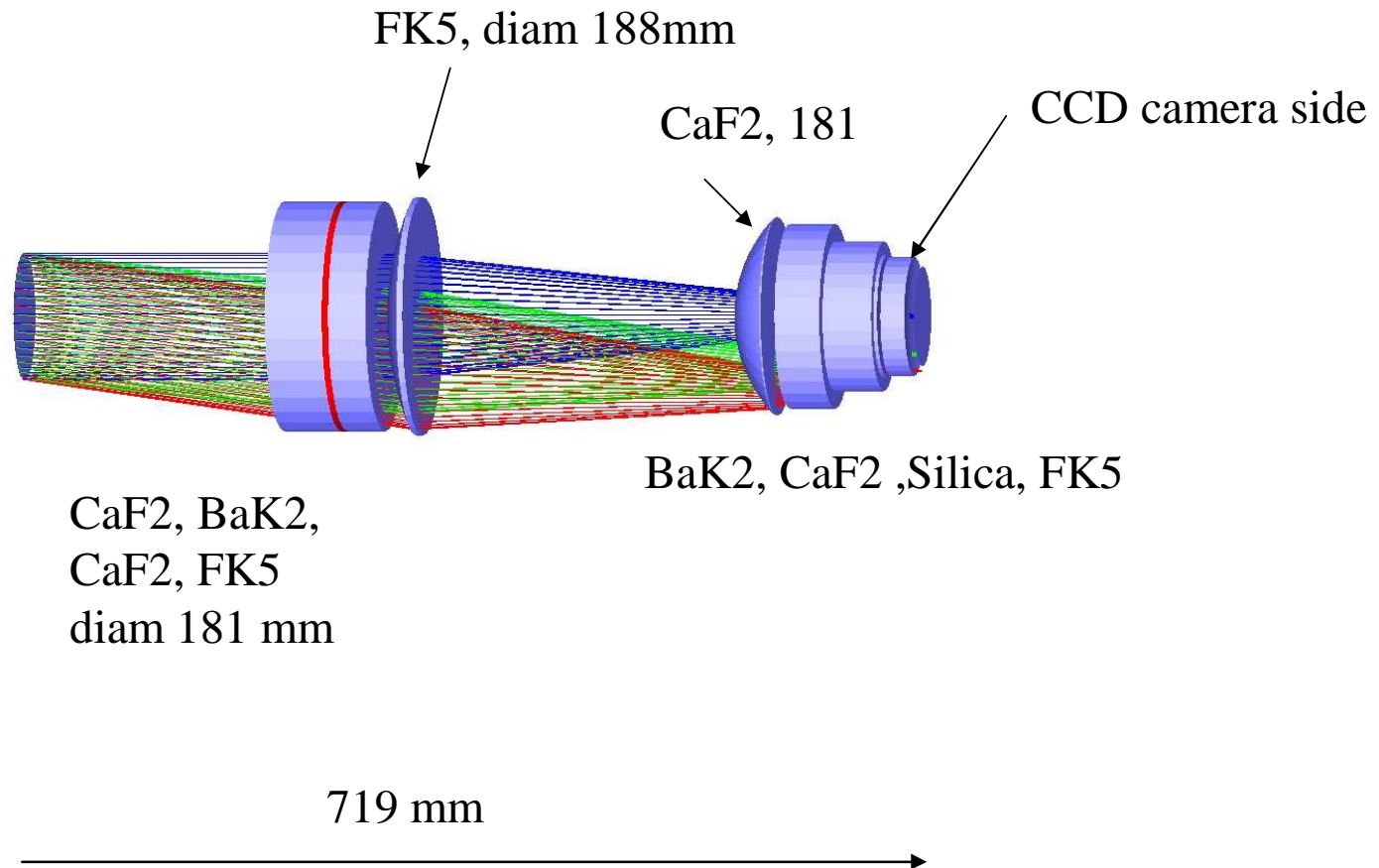
Aspect of the slit : aligned fibers

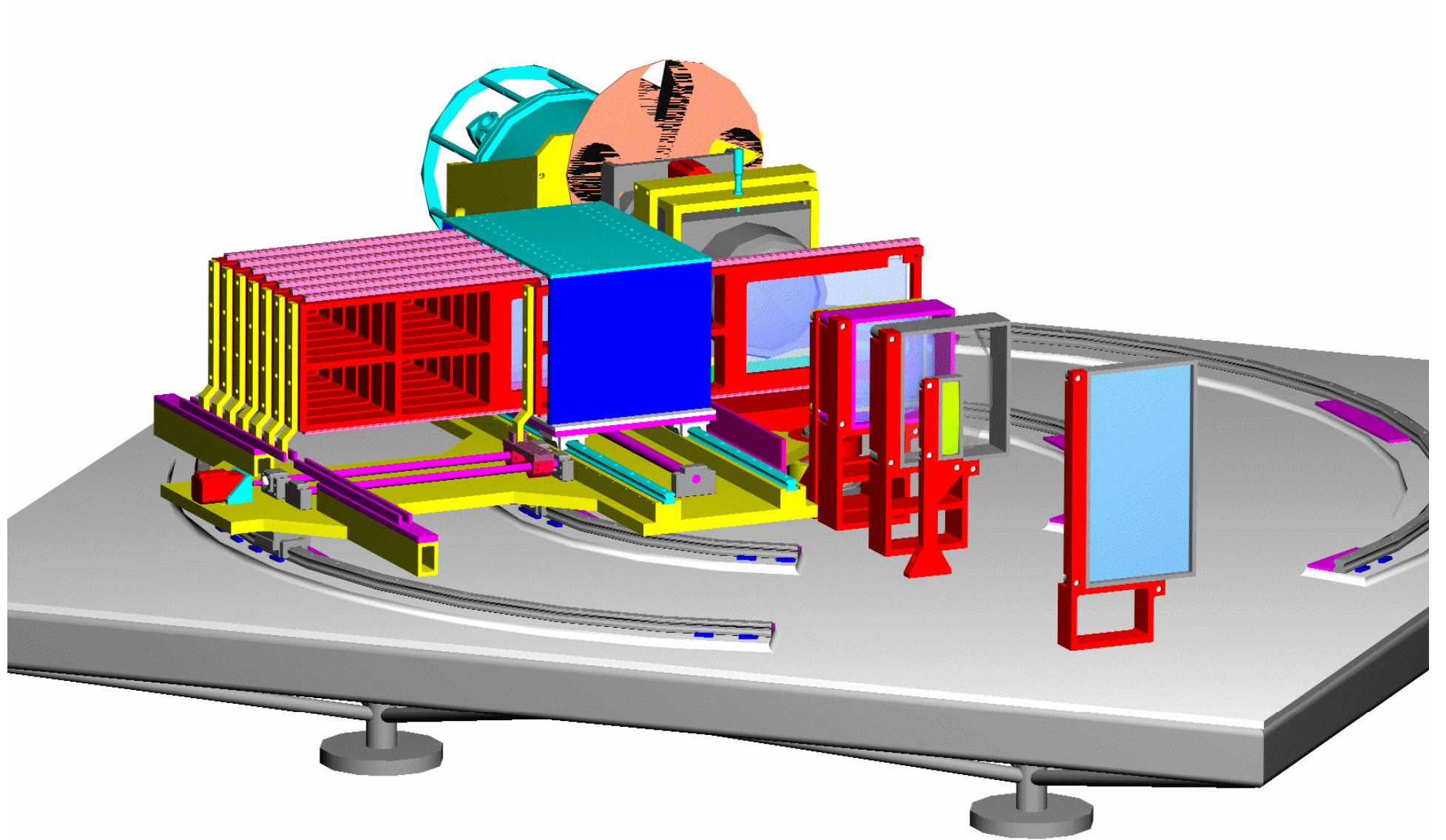


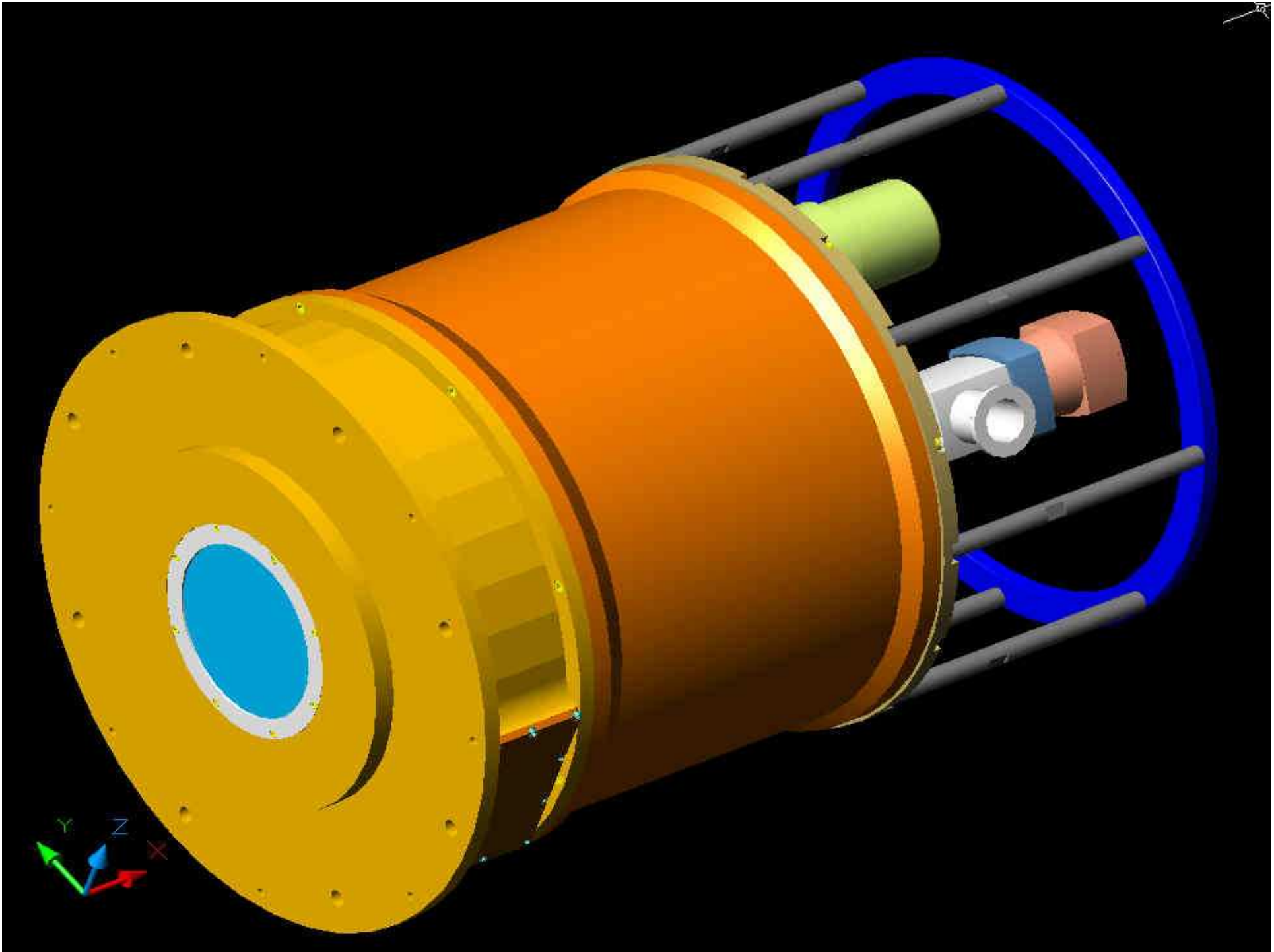
Core
Cladding
Buffer

A grayscale micrograph showing a row of eight circular fibers. Each fiber has a distinct central core and an outer cladding. The fibers are arranged in a regular pattern. Three lines point from the labels 'Core', 'Cladding', and 'Buffer' to the corresponding parts of one of the fibers. The 'Core' label points to the bright central spot, the 'Cladding' label points to the surrounding ring, and the 'Buffer' label points to the dark, textured material between the fibers.

The camera







0.350000

0.400000

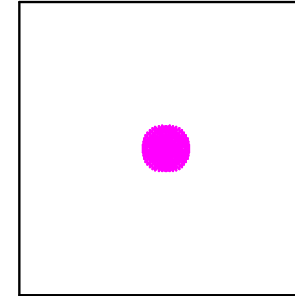
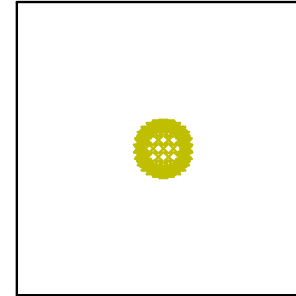
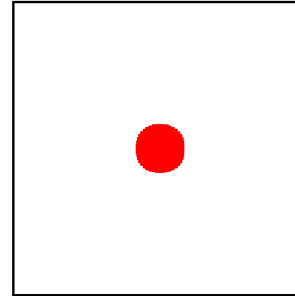
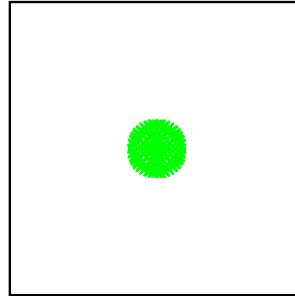
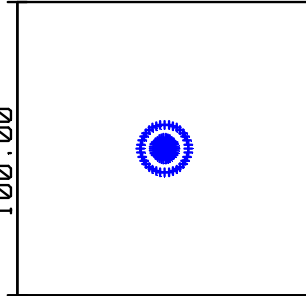
0.470000

0.650000

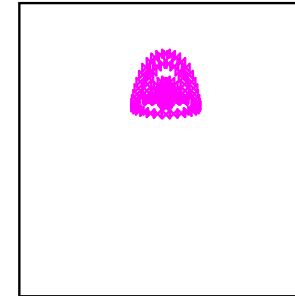
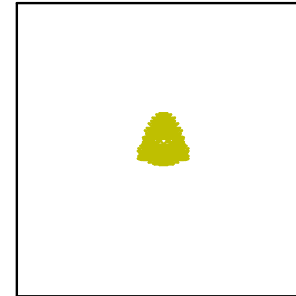
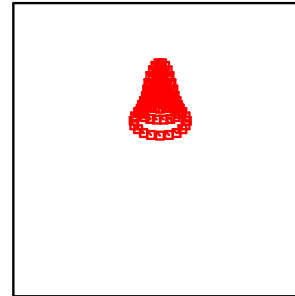
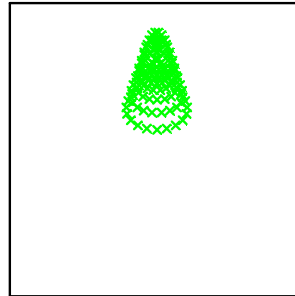
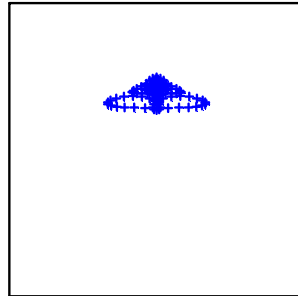
1.000000

0.0000 DEG

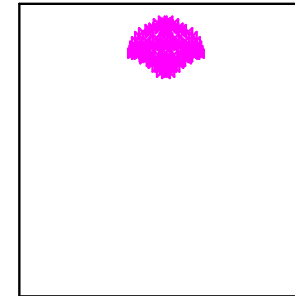
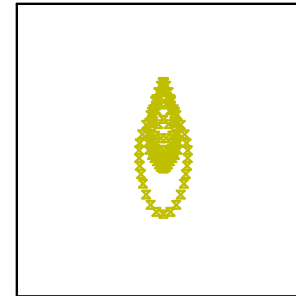
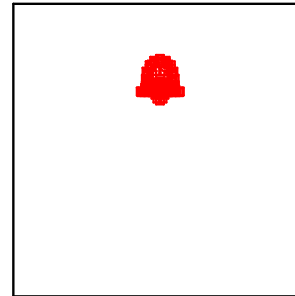
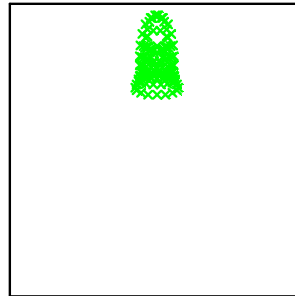
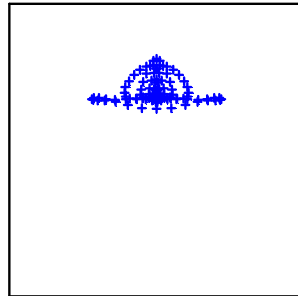
100.00



-5.8467 DEG



-8.2392 DEG



SURFACE: IMA

MATRIX SPOT DIAGRAM

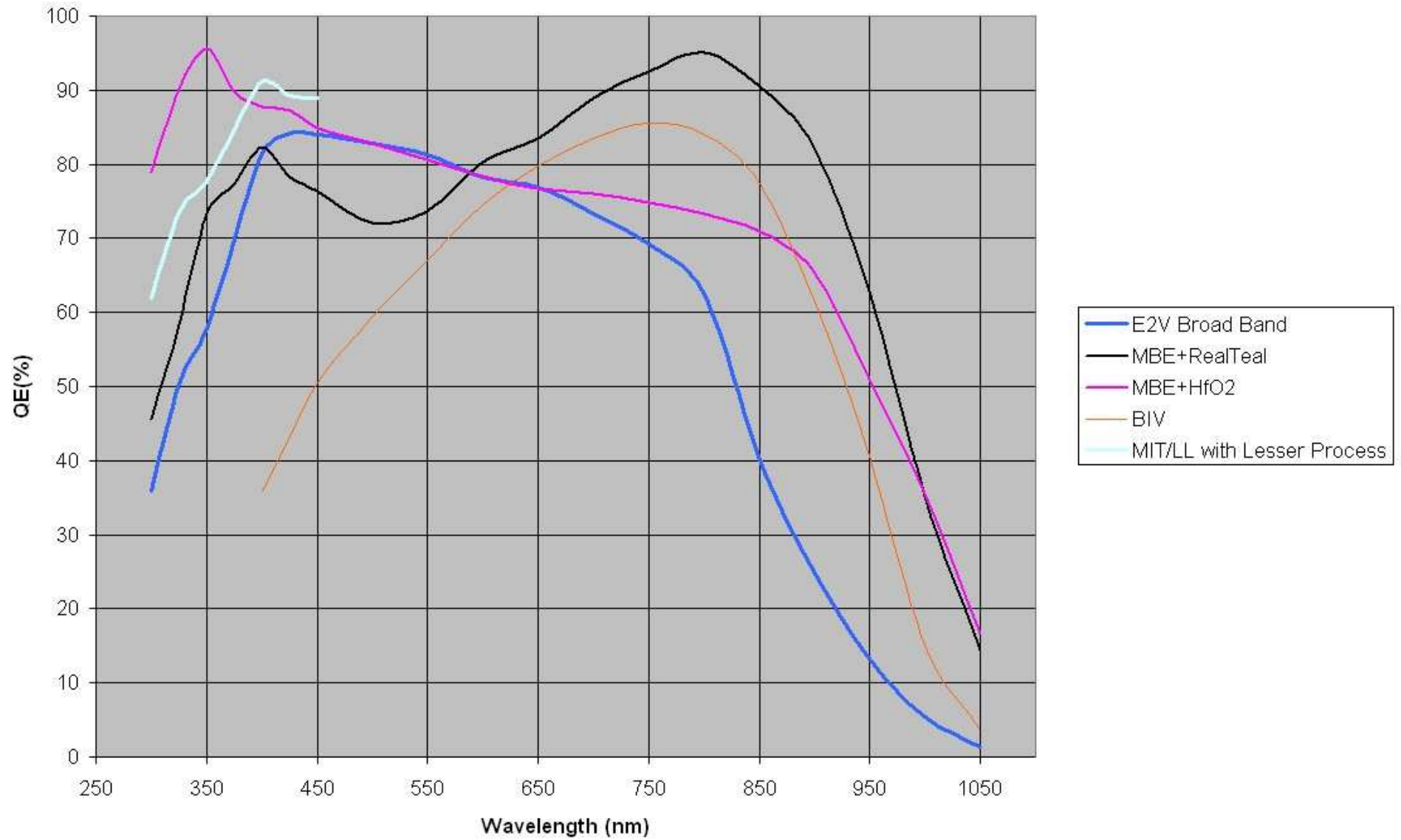
SOARS CAMERA: F/3.0, BROADBAND, VERSION 6.05
MON APR 16 2001 UNITS ARE MICRONS.

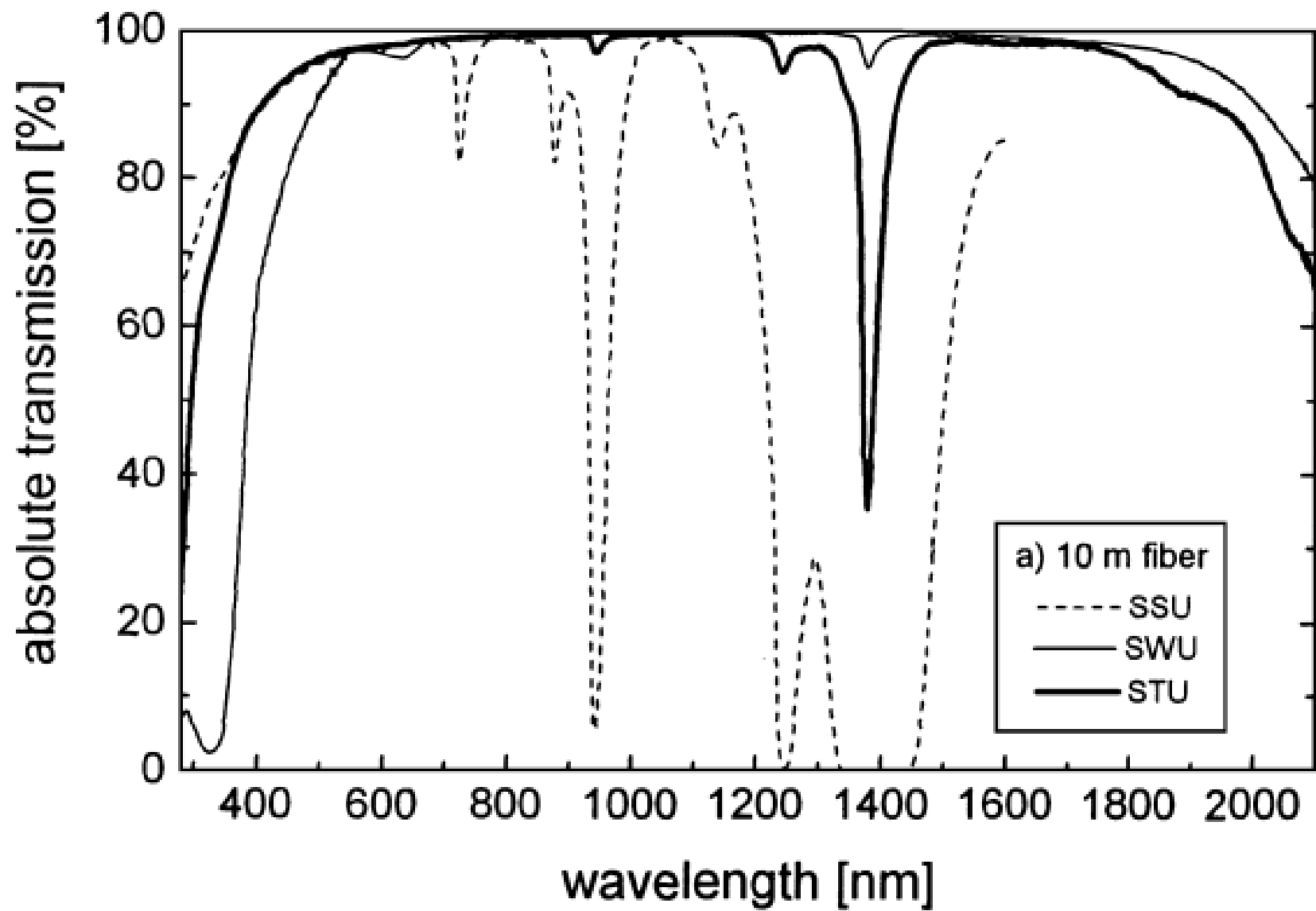
BOX WIDTH : 100

REFERENCE : CHIEF RAY

C:\ZEMAX\DAMIEN\20-03-2001\CAM605.ZMX
CONFIGURATION 1 OF 1

QE Comparison E2V versus MIT/LL





Efficiency at 350 nm

Atmosphere	T	56%	(often not included)
Telescope+ pick-off mirror	ϵ	80%	
Fore-optics		90%	
Fiber transmission		75%	
Loss due to FRD		80%	(improving; see poster by A.C. Oliveira)
Spectrograph transm.		70%	
Grating efficiency		80%	in some cases we reach 85%
CCD		70%	(possibly better)

We reach 9.5 % overall efficiency at 350 nm (including atmosphere!) This number is dependent on the CCD efficiency (we are not sure, what CCD are we going to have). Loss due to focal ratio degradation (FRD) is an important factor; we are presently studying ways of producing less stress in the fiber, at the slit.

Efficiency increases quickly with λ , about factor 2 better at 400 nm